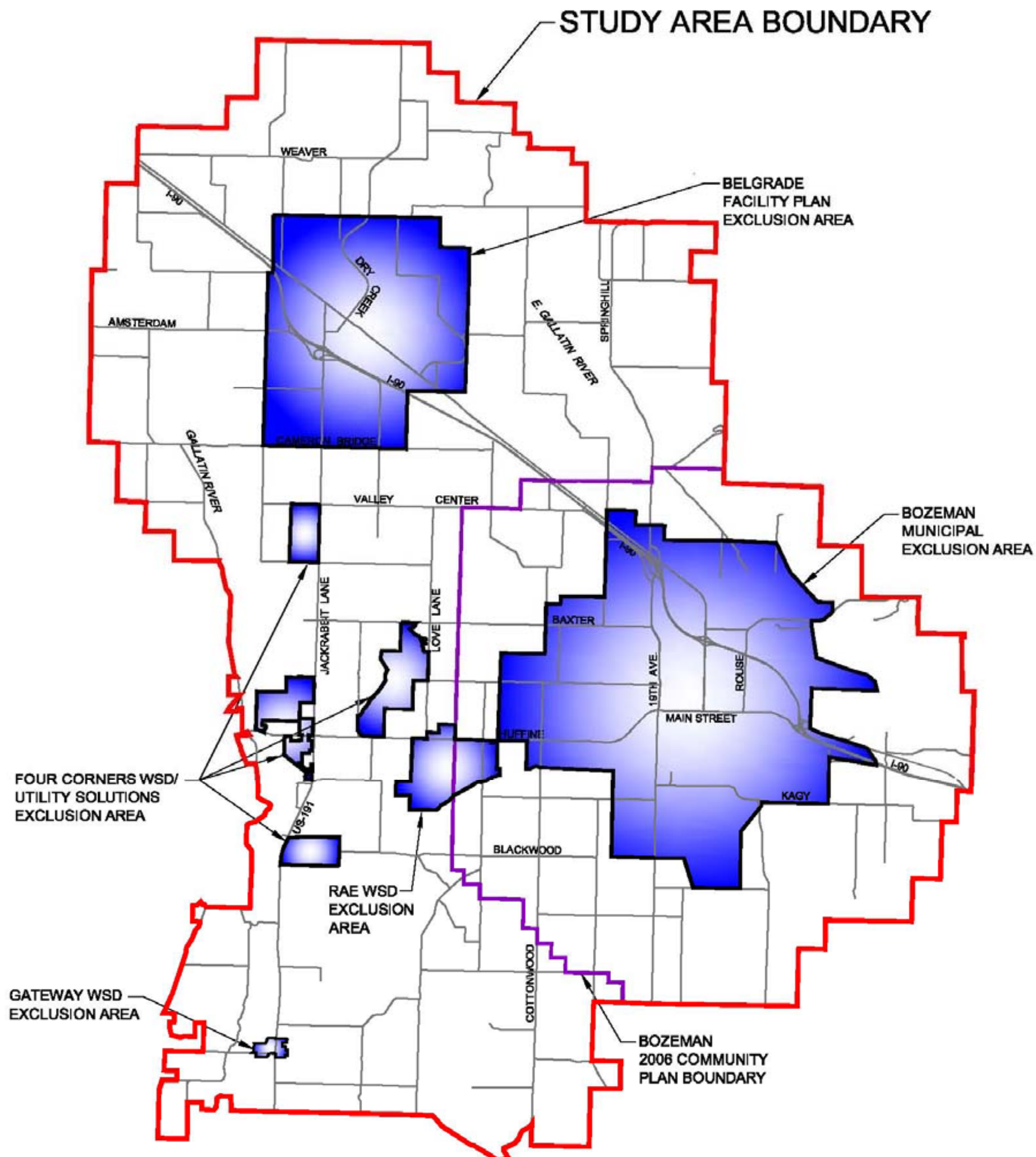
Gallatin County
Regional Wastewater Management System
Feasibility Study - Phase II

Working Draft Report—9/17/2010



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Gallatin County Regional Wastewater Management System Feasibility Study Phase II Project

Working Draft Report

9/17/2010

Prepared For:

Gallatin County Commission
Gallatin County Planning Board
Water and Wastewater Subcommittee

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

1. INTRODUCTION

Gallatin County Regional Wastewater Feasibility Study Phase 2 Report was prepared by Stahly Engineering & Associates, Inc at the request of, and with the assistance and funding by, the Gallatin County Planning Board Water & Wastewater Subcommittee. This report examines centralized wastewater management technologies, economics, and strategies for portions of rural Gallatin County as selected by the subcommittee.

This study is the result of community and agency (Gallatin Local Water Quality District [GLWQD]) concerns over high levels of expected growth, and a county wastewater management policy that universally favors a decentralized network of on site and small community type systems. A key concern is that the combination of high future densities and a decentralized approach may eventually threaten local groundwater quality. Given that scenario, certain areas may be better served by a centralized approach to wastewater collection, treatment, and disposal. Accordingly, this study evaluates population and density projections reflecting recent planning and zoning activities undertaken by the Commission and, based on those projections, identifies the general characteristics and locations of centralized collection, treatment and disposal facilities. In all, ten different alternatives for centralized service are evaluated.
In addition to examining various central treatment alternatives, this study presents additional information intended to assist the County in evaluating the adequacy of its current wastewater management policy including:

- estimates for near term and long term population growth and density by specific location within the study area,
- an economic comparison of decentralized and centralized approaches to wastewater management,
- an overview of available wastewater treatment technologies and performance including a description of what other Montana communities are doing,
- an examination of important centralized treatment constraints including water rights, permitting restrictions, subsurface and surface water discharge considerations, and physical constraints including soil and groundwater characteristics, and,
- spreadsheet tools that can be used by county staff for the evaluation of additional alternatives.

2. BACKGROUND

Prior to the current recession, Gallatin County experienced a sustained period of rapid population growth. According to published data, the County's population increased from 50,463 in 1990 to an estimated 87,359 in 2007 (U.S. Census Bureau 2007). This growth rate equates to a 42 percent increase over the last 17 years. Based on data provided by the GLWQD, approximately 22,000 persons (59 percent of new growth) located in rural areas; this new growth was supported with onsite wastewater systems.

A detailed review of the existing county planning and zoning classifications indicates that substantial rural area growth may continue for many years. The study area examined for this report (See Section 3, Figure 3A-1) is expected to grow from about 30,000 persons to 60,000 persons by the year 2030.

Note: Existing planning and zoning designations allow for as many as 260,000 persons within the study area boundaries.

At the present time, unincorporated areas of Gallatin County rely upon a de-centralized network of individual and/or community on-site wastewater treatment systems. For the most part, implementation of these systems uses an approval process centered on existing DEQ regulations - if a proposed system meets DEQ design standards it's usually approved by the County. According to the GLWQD, these systems are often approved independently of each other with little follow-up to evaluate important parameters such as cumulative groundwater impacts and ongoing system maintenance and performance.

Gallatin County contains 135 different public (serving 15 or more connections) wastewater treatment systems not including major systems serving cities and towns. About 90 percent of these systems are un-permitted. These systems are thought to discharge a total of about 500,000 gallons of wastewater per day into the groundwater. Together with the approximately 13,000 privately owned systems, the total effluent flowrate discharged by these systems is estimated at 3.5 million gallons per day. When these combined flows are compared to other major effluent sources, they represent the second largest source next to the City of Bozeman treatment facility which discharges approximately 5 million gallons per day.

The GLWQD has studied many of these systems concluding that lack of routine monitoring; unknown physical condition and effluent treatment performance; and the un-permitted discharge of treated effluent to the subsurface are all significant concerns. As rural growth continues, the GLWQD and many residents are concerned that the continued reliance on individual and community on-site systems will produce cumulative effects that may someday degrade local groundwater quality. A good example of this potential is the River Rock subdivision wastewater facility that has allegedly polluted down gradient drinking water wells.

Although the GLWQD has limited resources for the investigation of the hundreds of individual and community systems, Gallatin County cannot conclude that groundwater quality degradation is not a problem. If the experiences of other Montana communities such as Missoula County and the unincorporated community of Lockwood (adjacent to Billings) are any sort of guide, then the expectation for additional future groundwater contamination should be the rule and not the exception. Both of these communities have been working for several years to remedy nitrate contaminated groundwater resulting from the long term over-reliance on decentralized wastewater technologies.

The continued reliance on de-centralized systems is beginning to have significant repercussions within our community. For example, the author is aware of several commercial facilities with older on site systems that no longer function correctly. In most of these cases, the combination of new regulations and poor site (soils and groundwater) conditions are preventing system upgrades. Without viable long term alternatives for sewage treatment, some of these businesses may be forced to unnecessarily relocate (or possibly close) causing economic disruption to both the owners and employees.

3. STUDY METHODS

The study area population and density projections form the basis of this work. With the majority of the study area either planned and/or zoned, it's possible to more accurately project future populations and densities within the study area. Overall growth rates were determined using a three (3) percent net growth rate multiplied by the total population within the study area including excluded areas. This method accounts for the fact that growth occurring in excluded areas, such as Bozeman, impacts nearby unincorporated areas. The Gallatin County geographical information systems (GIS) database was then used to distribute the growth across the study area according to the planning and zoning characteristics of each land parcel within the study area. As a result, areas that are zoned for growth were allocated a higher proportion of growth than areas with lower densities.

The project team also developed spreadsheet models for estimating the characteristics, size, and cost of various types of wastewater collection, treatment, and disposal systems. The spreadsheets use population and service area as primary inputs. Outputs include collection, treatment, and disposal system sizes, land requirements, capital, and operating costs. When used in conjunction with the County's GIS database and population distributions, the spreadsheets facilitate rapid analysis of multiple wastewater management scenarios.

These spreadsheet models were also used to determine the economics for many of the decentralized system types now in use within the study area. The objective in doing this was to compare the life cycle costs of decentralized technologies to centralized system costs and to estimate the cost impact of future discharge regulations on the owners of decentralized systems.

With the population distributions and general facility characteristics known, the project team identified possible locations of these facilities. Potential sewer routes were based on factors such as topography and proximity to population centers and suitable effluent disposal sites. Treatment and disposal sites were identified by screening the GIS database to exclude areas with unsuitable characteristics by considering the location of surface waters, depth to groundwater, soil type, and physical interferences such as roads, structures, conservation easements, et cetera. Both the suitable and unsuitable sites were marked on the constraints maps providing a valuable planning tool useful for future related county activities. Administrative and legal constraints affecting various centralized treatment and disposal alternatives, such as water rights restrictions, were also identified and discussed where appropriate.

4. STUDY CONCLUSIONS

Major study conclusions are presented below. The conclusions are organized according to the originating section of the report.

Part 3A Study Area Definition

- Part 3A of this study presents the methods for projecting future populations within the study area. As discussed there, the Gallatin County GIS database, and existing planning and zoning designations, were used to distribute estimated future population growth according to zoning. This method is more precise than conventional methods that assume areas with high existing populations will continue to grow at high rates. In fact, in areas zoned for growth, the population tends to grow faster than in more mature areas. This effect is quite evident in rural Gallatin County where more than half of recent growth occurred outside population centers served by central sewer systems.

- A three (3) percent growth rate was applied to the entire existing population within the study area boundary. This allows for the fact that growth created by Bozeman and other excluded areas affects the growth of nearby unincorporated areas many of which are within the study area. (These projections are summarized in Tables 3A-2 and 3A-3 of the report.). Due to recent planning and zoning efforts, the study area 2030 population will be approximately 60,000 with about 36 percent or 22,000 located in portions of the study area having growth favored zoning.

- Similarly, the study area build out population will be approximately 260,000 with about 77,000 located in portions of the study area having growth favored zoning.

- The corresponding year 2030 densities in certain study area sub-regions will range from about 0.8 to 1.4 persons per acre increasing to between 3 to 6 persons/acre at build out. (Note: As a point of reference, Lockwood, Montana implemented a regional collection and treatment program at a current density of approximately one (1) person per acre.)

- Much of the land within the study area is zoned at densities that are unlikely to support centralized treatment. However, there are several key sub-regions within the study area where centralized treatment concepts are plausible. As a result, much of the study focused on the following six sub-regions:

  West Belgrade Area
  Belgrade Facility Plan Area (Outside the city limits)
  Valley Center Area
  Jackrabbit Area
  Four Corners Area
  Northwest Bozeman Community Plan Area

- Localized growth and infill rates within these sub-regions could be much higher than the overall study area population growth rate of 3 percent. This suggests that economical densities may be more rapidly attained than earlier engineers had thought. For example, Table 1-1 below indicates that the 20 year growth rates of certain sub-regions could exceed 100 percent. The corresponding densities are provided in Table 1-2 and show that by 2030, several sub-regions could meet or exceed densities of at least one (1) person/acre.

Table 1-1
Study Area Sub-Region Growth Rates

	Overall Population Change Year 2030	Overall Population Percent Change Year 2030
Sub-Region		
West Belgrade	+1435	+24
Belgrade Facility Plan Boundary Outside City Limits	+5600	+73
Valley Center	+3821	+165
Jackrabbit	+1525	+700
Four Corners WSD and areas served by Utility Solutions	+3618	+100
Northwest Bozeman	+2303	+650

Table 1-2
Study Area Sub-Region Density Information

	Projected Density (persons/acre) 2030	Zoned Density
Sub-Region		
West Belgrade	1.4	2.9
Belgrade Facility Plan Boundary Outside City Limits	1.1	3.0
Valley Center	0.90	4.0
Jackrabbit	0.80	4.3
Four Corners WSD and areas served by Utility Solutions	1.1	4.0
Northwest Bozeman	1.1	6.0

Part 3B Constraints Analysis

- Part 3B of this study evaluated a variety of constraints that could complicate the implementation of a centralized collection, treatment, and disposal facility. Of the many constraints identified, water rights could have significant impacts on the scope and location of any centralized facility. Essentially, the collection and disposal of wastewater is considered a diversion that may require mitigation. Because mitigation is only required for new water rights obtained after 2003, this issue would primarily affect recently established and planned future growth unless served by existing water rights that are free of mitigation provisions. The operator of a centralized wastewater facility may be able to mitigate any constraints through a variety of avenues including the acquisition of a mitigating water right or by using a wastewater disposal location located close to the fresh water source.

- Study area physical constraints such as depth to groundwater, soil type, and surface water locations are mapped in Figure 3B-1 of this report. This map suggests that a limited amount of land is suitable for locating and successfully operating a centralized wastewater treatment and ground water disposal facility. As much of this land is located in or near prime development corridors, the quantity of well located land with the required soil and groundwater conditions will continue to diminish over time. A good example of this trend is the Gallatin Heights subdivision, on Jackrabbit Lane, that was built on a site having excellent characteristics for a regional wastewater disposal facility.

- The lack of a central collection and treatment system will not prevent development within the study area. This is because state agencies are familiar with many decentralized technologies and will readily approve them. As a result, land development projects will continue without consideration for the need to preserve sites for possible future centralized facilities.

- Surface water discharge options are severely limited by a variety of discharge standards, most notably the non-significance trigger values for nitrogen and phosphorous. Examples of these restrictions can be found in Figures 3B-2 and 3B-3 of this report. These restrictions may be reduced if a credit for the removal of existing on site systems can be negotiated with Montana Department of Quality (DEQ). In this case, the higher removal efficiencies of a central facility would allow for it to serve more people with an equal or lower impact to the receiving water. Such an arrangement would require case by case negotiations with DEQ.

Part 3C & 3D Overview of Decentralized & Centralized Wastewater Treatment Technologies and Economics

- Part 3C and 3D of this study examine the treatment performance and economics of decentralized and centralized wastewater facilities. An economic comparison shows that over the long run, central treatment is more economical than individual on-site systems. For example, the ownership cost of decentralized (on-site) wastewater treatment systems ranges between about $2,000 and $4,000 per connection per year. In comparison, the cost of the centralized collection, treatment, and disposal facilities evaluated for the highest density sub-regions ranged from about $1,000 to $1,500 per connection per year.

- In addition to lower long term costs, centralized systems can produce an effluent significantly lower in conventional pollutants, nitrogen, and phosphorous than decentralized systems. In the case of new or more stringent effluent quality regulations, a centralized system is more easily upgraded than hundreds of individual systems.

- Because the cost of decentralized systems is typically included in the price of a home or commercial building, many people incorrectly assume that these systems have no cost. They are often unaware that wear and tear and depreciation are also significant long term costs. The true cost of these systems is often not apparent until a system fails and must be replaced. Some business owners along the Jackrabbit corridor are currently facing unaffordable upgrades to their older, failing on-site systems. As mentioned before, some of these owners are faced with the possible relocation or closure of their facilities because alternatives to on-site disposal are not available at this time.

Part 3E Spreadsheet Tools

- The cost of centralized wastewater collection, treatment, and disposal facilities is affected by a variety of factors each of which is discussed in Part 3E of this report. Of all the factors, the collection system cost has the largest effect on overall costs. Because the study area contains large tracts of undeveloped land, it's unlikely that sewer service to these areas would be 100 percent publically financed. More likely, developers would finance and install neighborhood sewers (defined as 12-inches or less) in grass roots developments with subsequent connection to a publically financed central trunk sewer. To account for this implementation method and the resulting range of collection system financing possibilities, the analysis spreadsheets include public financing factors that can be varied from 30 percent to 100 percent.

Part 4 Screening of Alternatives 1 Through 6

Part 4 conceptually evaluates collection, treatment, and disposal systems for several individual sub-regions selected from within the study area. These sub-regions, relative to the overall study area, are projected to contain the highest future densities and may represent the best opportunities to someday establish economical centralized collection, treatment, and disposal systems. The sub-regions are listed below and are also shown on Figure 4A-1.

Alternative 1. West Belgrade Central Collection & Treatment (CCT)
Alternative 2. Belgrade Facility Plan Area CCT
Alternative 3. Jackrabbit CCT
Alternative 4. Valley Center CCT
Alternative 5. Northwest Bozeman Community Plan CCT
Alternative 6. Four Corners CCT

- Because of higher current densities, the central treatment system economics for Alternatives 1, 2, or 4 are initially more favorable than for Alternatives 3, 5, or 6. If a centralized system was pursued by the County, the starting point should include one or more of the service areas identified in Alternatives 1, 2, or 4. Over the next 20 years, densities in all of these areas should produce central system costs in the range of $1,000 to $1,500 per connection per year.

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- A centralized treatment strategy that initially includes portions of the West Belgrade and Valley Center sub-regions, and possibly other (interested) adjacent areas, has the highest chance for success due to its current population density, favorable elevation for gravity sewers, and proximity to potential groundwater disposal areas. Such a system could be expanded to the south to incorporate additional sub-regions as their density increases and conditions permit. This concept is explored in more detail in Alternative 10 (Part 6 and below).

Part 5 Screening of Alternatives 7 Through 9

Part 5 conceptually evaluates collection, treatment, and disposal systems for larger portions of the study area. Each of these alternatives is briefly described below along with the corresponding conclusions.

- Alternative 7 considers a fully regional system serving the entire study area; in this alternative, average study area densities are assumed and then used to determine the overall system economics. This alternative is not feasible. Much of the land within the study area is zoned at densities that are unlikely to support centralized treatment. Serving these low density areas is uneconomical because the necessary collection system costs are too large and the rate payer base too small. If a centralized system serving the entire study area was constructed, an average density of at least 4 persons per acre would be necessary to achieve a reasonable cost structure. As the overall study area is planned and/or zoned at an average density of 2.8 people per acre, a fully regional system is not considered feasible.

- Alternative 8 explores the possibility of treated effluent hydropower generation with disposal in the Missouri River near Trident, Montana. In this case, a pressure pipeline is used to connect a treatment facility located northwest of Belgrade to a hydropower generation and effluent discharge facility located near Trident, Montana. This alternative has a variety of technical problems that most importantly include Missouri River non-degradation significance trigger levels that are difficult and expensive to meet and that also limit the amount of flow to the facility. Unfortunately, the power generation potential of this idea is miniscule when compared to the overall project costs. Lastly, the analysis shows that the cost of a pipeline to Trident, approximately 22 miles, is significantly more than the cost of groundwater disposal facility near Belgrade.

- Alternative 9 is identical in scope to Alternative 8 except that the Missouri River discharge option is replaced with a groundwater disposal system also located northwest of Belgrade, Montana. Using previously established methods, the annualized cost range for this alternative is about $1,200 to $1,700 per connection per year depending on which modeling assumptions are used.

Part 6 Screening of Alternative10

- In this alternative, the economics of a hypothetical system serving the West Belgrade and Valley Center sub-regions is explored in three (3) phases over a 20-year time horizon. This alternative is different from other alternatives in that it examines a project at several points during its duration. Initial costs of around $600 per connection per year are required during the initial phase where both central trunk sewers and neighborhood sewers are constructed to service the existing populations. As was the case with the Lockwood, Montana project, sewers are built first followed by a second phase where the treatment and disposal facilities are constructed and immediately commissioned. At this point, costs would rise to around $1,500 per connection per year. Phase 3 represents a time period 20 years from the project start. At this point, the debt from Phase 1 has been paid off resulting in a substantial lowering of costs to around $1,000 per connection per year.

- The presence of a central system is likely to stimulate growth and development beyond existing estimates. As a result, the cost structures shown for this alternative are likely conservative.

- Of all the alternatives considered, alternative 10 appears to be the best. This alternative has many positive attributes including: proximity to current and future growth areas; ability to serve most areas by gravity flow; higher chances for redevelopment and infill leading to lower user costs; proximity to many possible groundwater disposal sites; and, being centered near Belgrade, is well positioned for expansion to the southern portion of the study area as future conditions require.

Additional Conclusions

- During the next 50 to 100 years, additional restrictions on groundwater discharge and water diversions will likely require that regional treatment facilities incorporate reuse technologies such as ultra filtration or reverse osmosis followed by indirect reuse of effluent. Indirect reuse would be accomplished by pumping treated effluent up-gradient and injection into the groundwater. This possibility must be considered in the design of any centralized treatment facilities.

5. RECOMMENDATIONS

1. Because the study area is planned and zoned for 60,000 persons by 2030 and eventually up to 265,000 persons, the County, in consultation with the GLWQD, should review its current (decentralized) wastewater management policy to assess if another 500 to 1,000 small to medium sized treatment systems represents the most efficient and reliable way to preserve and protect local water quality.

2. Given the many benefits of centralized treatment including cost effectiveness, higher pollutant removals, and ease of upgrade and expansion for future conditions, the County should review its current wastewater management policy to determine if a properly located and implemented central system can aid in the preservation of local water quality.

3. In the event that such a policy shift is needed or is simply of interest, the County should then evaluate the legal and administrative requirements necessary for the County, or for a county encouraged entity, to provide and/or facilitate centralized service to portions of the study area.

4. Pending a shift in its wastewater management policies, the County should also consider acquiring or otherwise preserving for the public benefit, certain lands that could be used for future wastewater treatment and disposal facilities. The identification of such lands should follow the guidelines contained in this study and should be confirmed by the engineer prior to making any commitments.

5. Further, the County should consider enhancing the subdivision review process so that potential routes of regional sewer trunk lines are preserved and that approved community systems contain provisions for the possible future connection to a central system.

PART 2

PROJECT BACKGROUND

PROJECT BACKGROUND

1. INTRODUCTION

Prior to the recession of 2009-2010, Gallatin County experienced a sustained period of rapid population growth. According to published data, the County's population increased from 50,463 in 1990 to an estimated 87,359 in 2007 (U.S. Census Bureau 2007). This growth rate equates to a 42 percent increase over the last 17 years. More importantly, a significant portion of this new growth occurred outside of urban population centers in the form of rural development. During the same time period, approximately 9500 septic system permits were issued for onsite wastewater treatment and disposal systems. Assuming a minimum population equivalent of 2.3 persons per permit means that an estimated 22,000 people, or 59 percent of total growth, located in rural areas.

Unincorporated Gallatin County relies upon a de-centralized network of individual and/or community on-site wastewater treatment systems. Many of these existing systems share common characteristics including lack of routine monitoring, unknown physical condition and effluent treatment performance, and the un-permitted discharge of treated effluent to the subsurface. As growth continues, many residents are concerned that the continued reliance on individual and community on-site systems will produce cumulative effects that someday degrade local groundwater quality. As high levels of groundwater quality are essential to the regional future, implementation of a regional or centralized wastewater treatment facility may reduce the likelihood of further groundwater quality degradation.

<u>The Gallatin Local Water Quality District Study</u>

This study was prepared in early 2010 by the Gallatin Local Water Quality District for the Wastewater and Water Sub-Committee of the County Planning Board. This work is likely the most comprehensive assessment of county-wide trends in wastewater management currently available. Of particular interest are the trends in wastewater treatment within the rural areas of Gallatin County. Some of the more significant trends and facts are summarized below:

- Gallatin County contains 135 different public wastewater treatment systems not including major systems serving cities and towns. About 90 percent of these systems are un-permitted. These systems are thought to discharge a total of about 500,000 gallons of wastewater per day into the groundwater.

- Of the approximately 15,700 non-public septic system permits issued since 1966, approximately 13,350 systems remain active. Little is known about the condition maintenance, or treatment performance of these systems. Assuming that each septic system services a "typical household" of 2.3 persons means that cumulative flows could be on the order of 3 million gallons per day from these systems.

- Together, wastewater flows from Gallatin County's rural public and non-public wastewater systems total at least 3.5 million gallons per day. When compared to flows generated by the larger cities such as Bozeman (5.5 million gallons/day) and Belgrade (600,000 gallons/day), the rural contribution represents a significant portion of total flows.

- Nearly all of the rural non-public and public wastewater treatment systems discharge effluent into the groundwater. Impacts to groundwater from these discharges depend on a variety of factors including the treatment efficiency, location of discharge, and the subsurface geologic and hydro geologic conditions. With over 13,000 non-public systems plus another 141 un-permitted public systems discharging, it's impossible to be confidant that impacts are not occurring. At the same time, most county residents, except those served by Bozeman, obtain their drinking water from individual and community water wells that draw from the same groundwater source.

- There is concern within the scientific community that trace levels of pharmaceutical compounds contained in treated wastewater have the potential to disrupt the endocrine systems of both animals and humans. Where individuals or communities utilize groundwater for drinking water supplies, the presence of endocrine disruptor compounds may become a future problem. In the event that wastewater treatment facilities are required to provide additional treatment for the removal of these compounds, the cost and complexity of this endeavor requires central facilities.

The Gallatin County Regional Wastewater Feasibility Study Phase I

The Gallatin County Planning Board originally considered centralized or regional wastewater treatment concepts in 2005 and 2006. A Phase I Regional Wastewater Study ("RWS"), prepared in 2007, considered the possibility of systems servicing high-density growth areas along the U. S. Highway 191 and Jackrabbit Lane corridor between Gallatin Gateway and the City of Belgrade, Montana.

The Phase I study concluded that areas currently served by the existing Bozeman and Belgrade collection and treatment facilities should not be combined into a large regional system. The basis of this recommendation is that a fully regional system would produce wastewater volumes too large for practical disposal in a single location. In addition, combining systems could possibly mean that the communities of Bozeman and Belgrade would receive tighter discharge restrictions than currently exists.

Another conclusion was that rural areas may not be ready to support centralized wastewater management collection treatment and disposal for 40 to 50 years. Based on this conclusion, the study recommended that future planning efforts emphasize a more localized approach. Although a possibility, a more localized approach must not neglect today's opportunity to establish regional collection corridors and treatment and disposal areas that may someday prove useful. While those opportunities currently exist, ongoing development threatens to take key locations out of play.

Differences Between The Phase I and Phase II Studies

The Phase I study utilized a census based approach to population estimating rather than considering actual zoning designations of the affected lands. It assumed that future growth would occur in or adjacent to existing large population centers such as Bozeman and Belgrade with no defined method for distributing population into rural areas in proportion to zoning. The Phase II study uses county GIS data combined with planning and zoning data to spatially distribute future population growth across a wider area with a reduction of the urban growth rates and densities.

The basis of the Phase I population prediction and distribution is the 2000 census data. Historic growth rates (5.75%) were used from 2000 to 2005 to obtain 2005 population. As described in the text of the Phase I study, the 2025 (20-year) population and distribution was determined by applying a 5% growth rate to each census block. However, checking the 2025 populations provided in Table 1 of the Phase I study it appears that the growth rate applied was actually only approximately 3.5% for each block except for the City of Bozeman which truly had a 5% growth rate applied. This skewed the future population and distribution towards the City of Bozeman.

Although the Phase I study area is smaller than the Phase II study area, the additional areas do not contain significant population centers. Comparing the population estimates of the two study areas, the Phase I 2025 population is 124,620 and the Phase II 2030 population is 128,252. Although the Phase II study only assumed a 3% growth rate compared to the 3.5% and 5% (for Bozeman) used in the Phase I study.

The Phase I study predicted that Bozeman would represent 74% of the 2025 population, Belgrade 13%, higher density rural areas 10% and low density rural 2.8%. The Phase II study predicts that Bozeman would represent only 63% of the 2030 population, Belgrade 10%, higher density rural areas 17%, lower density rural areas 6%. The Phase II study predicts that the higher density rural areas of the study area will make up a larger proportion of the future study areas population.

Table 2-1
Phase I & Phase II Comparison Table

Area	Phase I Study 2025	Phase II Study 2030
Study Area	124,620 (100%)	128,252 (100%)
Bozeman (including BCP)	92,500 (74%)	81,407 (63%)
Belgrade	15,578 (13%)	13,410 (10%)
Higher density rural (>2 people/acre)	13,024 (10%)	21,281 (17%)
Lower density rural (<2 people/acre)	3,518 (3%)	*7,967 (6%)

***Phase II study area includes significantly more rural low density lands than Phase I study area**

The Phase II study is designed more as a planning tool that can serve county planners over the long term. To that end, it is significantly more detailed than the Phase I study in certain areas:

- The Phase II study incorporates county GIS data and mapping information into constraints maps that can be used to identify potential areas for treatment facilities and treated effluent groundwater disposal facilities. This information is essential to assessing what available lands remain as well locating future facilities. Constraints maps were developed considering soil type, depth to groundwater, proximity to surface water, and proximity to physical barriers to name a few. Other factors with the potential to significantly affect regional facilities such as water rights were also evaluated and incorporated where appropriate.

- This study provides an extensive economic and performance analysis of both de-centralized (on-site) and centralized wastewater treatment facilities so that the cost to residents and businesses can be fairly compared in terms of both cost and environmental protection. (Contrary to common perceptions, on site wastewater treatment systems have significant costs associated with them.)

- The economic analysis is contained in spreadsheet tools that allow for the rapid analysis of multiple areas, populations, treatment requirements, and financing options in the event that the county desires to evaluate future scenarios that are different from those contained in this report. The spreadsheets allow key assumptions such as treatment system costs and collection main public financing percentage to be varied according to county requirements. This allows a range of costs to be established resulting in a more thorough analysis of financial feasibility.

- The Phase II study also provides a regionalization example showing the key steps necessary for creating a system. Understanding the steps involved is an essential ingredient of the planning process.

2. SCOPE OF WORK

Subsequent to the Phase I and GCLWQD studies steps towards infrastructure planning have been taken by the Commission in its growth policy implementation effort. Consistent with what the Phase I study recommended, and pursuant to the conclusions of the Wastewater and Water Sub-Committee of the County Planning Board, additional study of regional wastewater treatment concepts was deemed necessary and appropriate. In view of the preceding discussion, this study will accomplish the items as listed below.

1. Consider a somewhat larger study area than what was used in the earlier study,
2. The Study Area excludes those areas within, surrounded by or nearly enclosed by the Bozeman municipal boundary, within the portion of the Belgrade water plan boundary, within the Rae County Water and Sewer District service area, within the Gallatin Gateway Water and Sewer District boundary, and within the Four Corners Water and Sewer District boundary and areas, if any, outside such District for which there are in effect contracts for Utility Solutions to provide service.
3. Reflect population and density projections based on a different approach to assumptions and reflect Commission efforts since that time,
4. Identify locations for facilities that would be appropriate to serve future as well as near term needs in sufficient detail so that this Commission can begin now to preserve the ability of future Commissions to take then necessary and appropriate steps, and
5. Indicate which of those facilities might be appropriate to pursue in the near term.

A copy of the detailed scope of work can be found in Appendix A.

PART 3

PROJECT METHODS

SECTION A
STUDY AREA DEFINITION

1. STUDY AREA DESCRIPTION

The study area boundary was previously defined by the wastewater subcommittee, and is a refinement of the Phase 1 study area. The study area can be generally described as a region of the Gallatin Valley extending from Bozeman to Belgrade and south to Gallatin Gateway. The study area boundary consists of approximately 122,000 acres, compared to the Phase 1 study area boundary of 77,000 acres. Most of the study area expansion consists of areas north of I-90 and east of Gallatin Gateway. Portions within the study area boundary are excluded from the study area.

Note: The term "Study Area" refers to the area within the study area boundary less the excluded areas. This configuration is shown in Figure 3A-1.

The excluded areas are within the:

- Bozeman municipal boundary and areas surrounded or nearly enclosed by the Bozeman municipal boundary,
- Belgrade water plan boundary,
- Rae County Water and Sewer District,
- Gallatin Gateway Water and Sewer District, and
- Four Corners Water and Sewer District and areas outside of the District that are being served by Utility Solutions.

The excluded areas consist of approximately 27,000 acres. The net study area consists of approximately 95,000 acres.

Table 3A-1
Study Area Table

	Area in Acres
Inclusive of Study Area Boundary	121,863
Excluded Areas within Study Area Boundary	26,969
Bozeman Municipal Area and enclosed GCZD 1 and GCBAZD lands	15,560
Rae WSD	1053
Belgrade Water Facility Plan Boundary	8250
Four Corners WSD and areas served by Utility Solutions	1908
Gallatin Gateway WSD	97
Study Area	94,893
Within Bozeman Community Plan outside of Municipality	25,149
Other Areas	69,744

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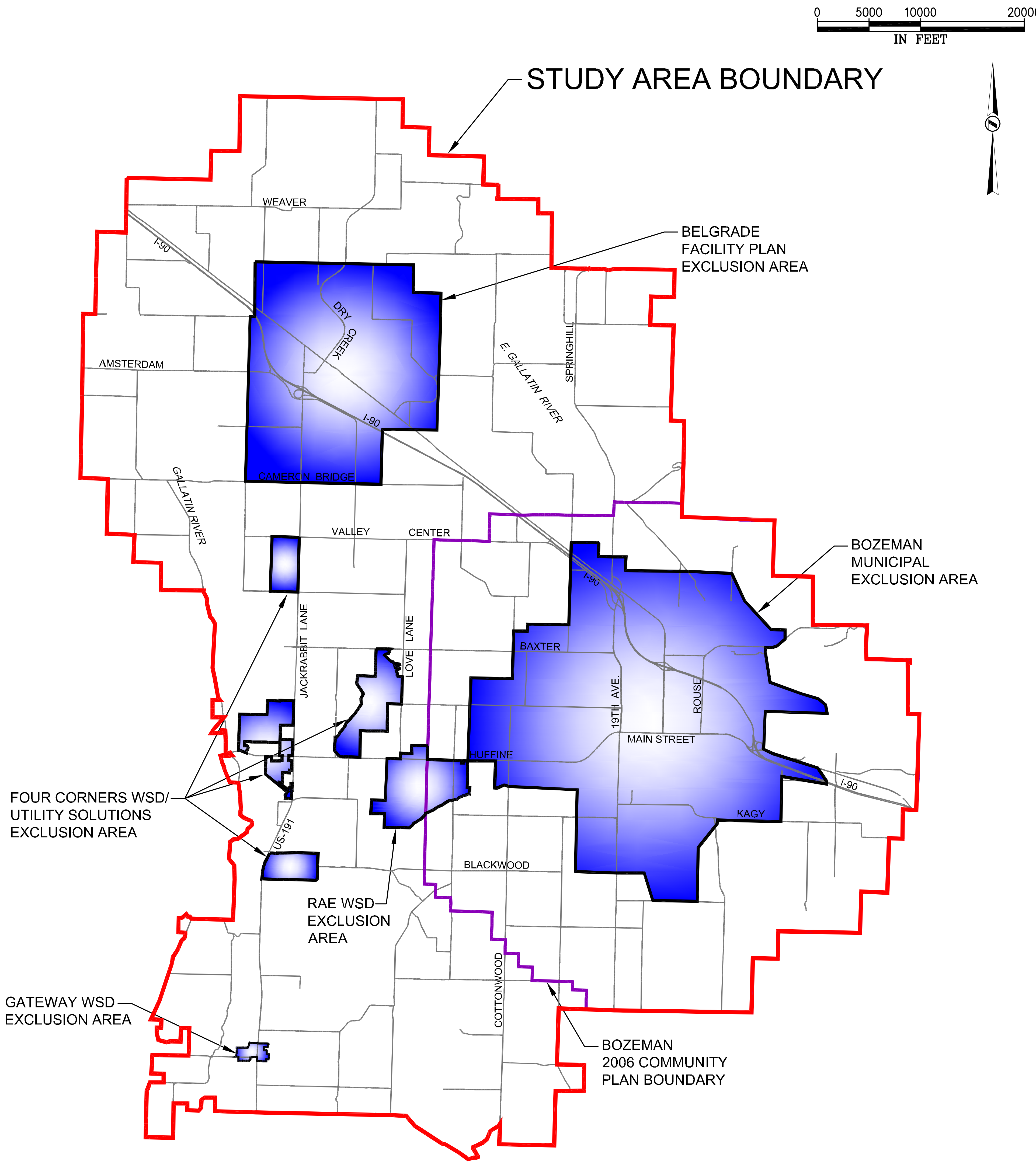

NOTES:

1. GIS DATA SUPPLIED BY GALLATIN COUNTY GIS DEPARTMENT VIA GALLATIN COUNTY PLANNING DEPARTMENT. SHOWN IN MONTANA STATE PLANE (FEET).

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FIG. 3A-1

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STUDY AREA OVERVIEW

REGIONAL WASTEWATER TREATMENT FEASIBILITY STUDY, PHASE 2
GALLATIN COUNTY, MONTANA

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2. LAND USE AND ZONING

The study area encompasses most of the high-growth areas of Gallatin County. In response to this growth much of the study area has undergone growth planning efforts and zoning. In addition to the Gallatin County Growth Policy document the following neighborhood or community scale plans are within the study area. Approximately 72% of the study area has been zoned, (counting Belgrade Planning Zoning). Another 12% of the study area has undergone specific neighborhood or community planning. 16% of the study area has only the Gallatin County Growth Policy guiding future growth. A large portion of this zoning and planning has been established since the Phase 1 study was completed.

The major planning areas within the study area are:

- Bozeman Community Plan,
- Gallatin County Bozeman Area Plan (overlaps most of the BCP area),
- Four Corners Neighborhood Plan,
- Belgrade Area Plan within the Belgrade Planning Jurisdiction, and
- Gallatin Gateway Community Plan.

The zoning districts within the study area:

- Gallatin County Bozeman Area,
- Four Corners,
- Belgrade Area (currently on hold),
- River Rock,
- East Gallatin,
- Hyalite,
- Bridger Canyon,
- Wheatland Hills,
- Zoning District 6, and
- Middle Cottonwood.

Of the planning areas only the Bozeman Community Plan and the Gallatin Gateway Plan *do not* have supporting zoning implemented. These two plans are described below.

- The area around Bozeman falls within the Bozeman Community Plan which was completed in 2009. The Bozeman Community Plan covers approximately 42,500 acres. The area within the BCP is planned to one day become part of Bozeman. The large size of the planning area dictates it may take several decades before all of this area is incorporated into Bozeman. Most, but not all, of this area is currently zoned within the Gallatin County Bozeman Area district. Also of note, most of the area planned for future city growth is currently zoned agricultural, limiting growth until annexation into the Bozeman.

- The Gallatin Gateway Community Plan provides fairly specific density guidelines, and though not as detailed as zoning regulations, it provides some initial planning encouragement.

3. POPULATION ESTIMATES AND TRENDS

<u>Existing Population</u>

Census data is available from 2000, and is described in detail in the Phase 1 study. Significant growth has occurred within the study area since 2000, and population and geographic distribution have changed accordingly. As an alternative means of assessing existing population within the study area, the Gallatin County Structures GIS database was used. This database is maintained to assist emergency responders in locating rural homes, and appears to be fairly complete.

True population density is defined by purely residential occupation of dwellings. For infrastructure planning purposes an equivalent density is more useful. Equivalent population density takes into account the effect of occupation and use of commercial and industrial properties. The desired result is to include a population (equivalent population) for commercial and industrial uses that would impart the same demand on infrastructure as the commercial or industrial use does. In wastewater terms non-residential land uses assigned an equivalent year-round population that would create similar wastewater flow rates to the non-residential use. The equivalent population will be higher than the true residential population of an area. However, since a typical person's off-site wastewater uses are smaller than their residential use this difference is typically small.

Future Population Projection Methods

Future population estimates and growth trends are established in two ways. The traditional method of utilizing growth rates and terms is used to project future population within defined timeframes. Secondly, zoning designations are used to project a maximum potential population "build out" within the study area. This method is used when necessary to analyze long-term trends.

Additionally, with the implementation of zoning throughout much of the study area, a spatial distribution of population can be determined. This is more precise than a growth rate approach that assumes areas with high existing populations will continue to grow. In fact, with zoning that allows growth, the opposite occurs, and areas with less population tend to grow faster than areas already built-out. With a zoning based projection, future growth is allocated to areas with lower population densities that are zoned for growth.

Future Population Density Projection by Zoning

Existing land use plans and zoning data were researched to determine build-out densities within the Study Area. Additionally, gross density, or number of people per overall area is used to determine the equivalent population over the entire study area including areas that are parks, open spaces, roads, etc. This is sometimes delineated specifically by zoning or planning documents, but in areas where only minimum lot size is specified, the gross density was estimated based on typical development patterns. To obtain population density from units or lots an occupation rate of 2.3 people /unit or lot was used, based on 2000 census data for Bozeman.

Summary of Existing Zoning and Land Use

Figure 3A-2, Study Area Zoning and Planning, shows the existing zoning and planning designations within the study area. The zoning district and designation for each zone within the study area as it relates to future population density is described below. Additionally an index abbreviation is included with each designation, corresponding to the map legend. Since the zoning designations extend through the study area exclusions, the zoning designations are provided for all areas (excluded areas too) within the study area boundary. Areas that are completely within the excluded areas (municipal areas) have been given a simplified designation applied to all of the municipal area.

Bozeman Community Plan Area and Bozeman Area Zoning

Bozeman Municipal (BOMUN)

Area within or nearly or completely surrounded by the existing Bozeman Municipal boundary. This is given a population density corresponding to densities supported by the Bozeman Community Plan representing infill and redevelopment within the city to obtain higher future population densities. An overall (gross) equivalent population density of 8 people/acre is used.

Undeveloped Land in Bozeman Area Zoning AS (BAAS)
Area within the Bozeman Community Plan that is currently zoned in the Bozeman Area Zoning district as agricultural. City of Bozeman (COB) Unified Development Ordinance (UDO) requires a minimum net density of 6 units/acre. Estimate gross density of approximately 3.5 unit/acre after roads, parks, etc removed. Gross density of 8 people/acre.

Bozeman Area RS (BARS)
Existing subdivisions fully developed not likely to undergo redevelopment at higher densities. Typically 1 unit per acre net, estimate 0.75 units per acre gross, or 1.73 people/acre.

Bozeman Area R1 (BAR1)
10,000 sf minimum lot size, estimate 2.5 units per acre gross, or 5.75 people/acre.

Bozeman Area R2 (BAR2)
7,000 sf minimum lot size, estimate 3.0 units per acre gross, or 6.9 people/acre.

Bozeman Area R3 (BAR3)
5000 sf minimum lot size or 3000sf per unit of multifamily, estimate 3.5 units per acre gross, or 8 people/acre.

Bozeman Area RMH (BARMH)
5500 sf per unit, estimate 3.5 units per acre gross, or 8 people/acre.

Bozeman Area RO (BARO)
5000 sf minimum lot size or 3000sf per unit of multifamily, estimate 3.5 units per acre gross, or 8 people/acre.

Bozeman Area B1 (BAB1)
Neighborhood commercial uses. Estimate maximum density equivalent to 3 people/acre.

Bozeman Area M1 (BAM1)
Light manufacturing uses. Estimate maximum density equivalent to 3 people/acre.

Bozeman Area PLI (BAPLI)
Public institutions. Estimate maximum density equivalent to 2 people/acre.

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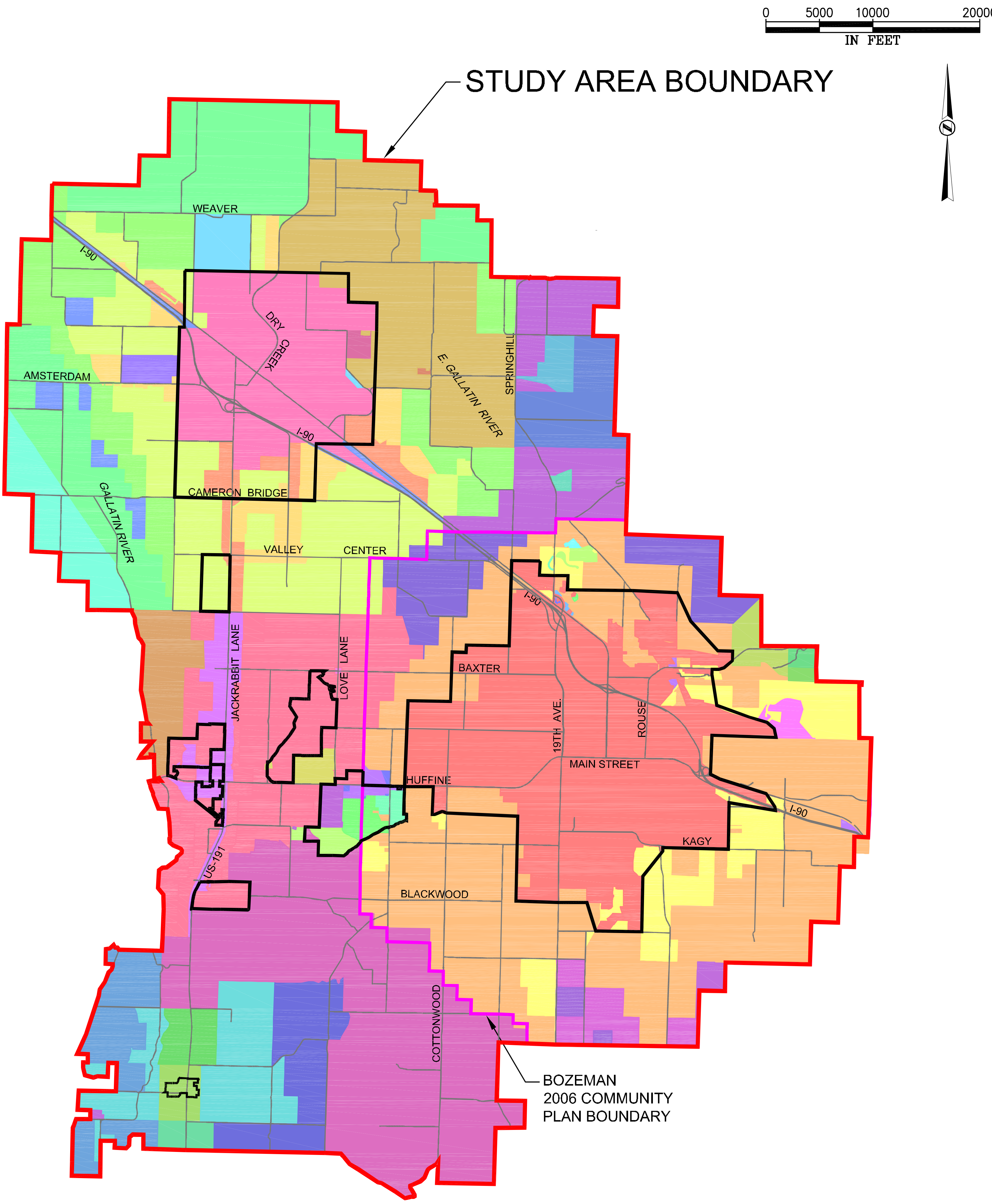

KEY

BOMUM	BGPC	FCRRA	EGNC
BAAS	BGPMU	FCLDRRA	EGRR
BARS	BGPSU	FCPLI	BCAE10
BAR1	BGPRS	GPCR	BCAE20
BAR2	BCPR	GPHN	BCRF20
BAR3	BGPRRA	GPHS	WHRS1
BARMH	BGPAPT	GPEX	Z6RS10
BARO	BGPPLI	GPRW	MCAR
BAB1	RVRK	GPRE	UZBCP
BAM1	FCC	HRX	UZMD
BAPLI	FCNC	HRR5	UZLD
BGMUN	FCMU	EGCD	

* See report for detailed zoning/planning descriptions

NOTES:

1. GIS DATA SUPPLIED BY GALLATIN COUNTY GIS DEPARTMENT VIA GALLATIN COUNTY PLANNING DEPARTMENT. SHOWN IN MONTANA STATE PLANE (FEET).

2. ZONING CODE DESIGNATION REPRESENTS DISTRICT (FIRST LETTERS) AND DESIGNATION (LAST LETTERS. SEE REPORT FOR FULL ZONING DESIGNATION DESCRIPTION.

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FIG. 3A-2

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STUDY AREA ZONING & PLANNING

REGIONAL WASTEWATER TREATMENT FEASIBILITY STUDY, PHASE 2
GALLATIN COUNTY, MONTANA

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Belgrade Planning Jurisdiction

Belgrade Municipal (BGMUN)
Average density within city limits or city zoned areas is approximately 5 people/acre.

Belgrade Planning Commercial (BGPC)
Commercial uses of higher intensity, estimate similar to Belgrade municipal area of 5 people/acre.

Belgrade Planning Mixed Use (BGPMU)
Mixed use but estimate overall gross density similar to suburban of 1.75 units per acre or 4 people/acre.

Belgrade Planning Suburban (BGPSU)
Base gross density of 1.75 units per acre, or 4 people/acre.

Belgrade Planning Rural Suburban (BGPRS)
Base gross density of 1 unit per 10 acres, or 0.23 people/acre.

Belgrade Planning Rural (BGPR)
Base gross density of 1 unit per 20 acres, or 0.12 people/acre.

Belgrade Planning Rural Residential /Agricultural (BGPRRA)
Base gross density of 1 unit per 40 acres. or 0.06 people/acre

Belgrade Planning Airport Authority (BGPAPT)
Airport property low density of use overall, estimate similar to one unit per 20 acres from airport facilities, or 0.12 people/acre

Belgrade Planning Public Lands (BGPPLI)
State owned lands estimate very low density of 0.02 people/acre

River Rock (RVRK)

The existing population is approximately 1500 people on approximately 300 acres or 5 people/acre.

Four Corners

Commercial (FCC)
Commercial uses of higher intensity estimate 5 people/acre.

Neighborhood Commercial (FCNC)
Mixed use but estimate overall density similar to RRA of 1.75 units per acre, or 4 people/acre.

Mixed Use (FCMU)
Mixed use but estimate overall density similar to RRA of 1.75 units per acre, or 4 people/acre.

Rural Residential /Agricultural (FCRRA)
Base gross density of 1.75 units per acre, or 4 people/acre.

Low Density Rural Residential/Agricultural (FCLDRRA)
Base gross density of 1 unit per 10 acres, or 0.23 people/acre.

Public Lands (FCPLI)
MSU Agricultural Experiment Station. Estimate very low density of 0.02 people/acre.

Gallatin Gateway Community Plan

Core (GPCR)
Core area with future density similar to historical density of 4 unit/acre gross, or 9.2 people/acre.

Highway North (GPHN)
Gradational density from rural to town core. Estimate build-out density of approximately 1 unit per acre net, or 0.75 units per acre gross, or 1.73 people/acre.

Highway South (GPHS)
Gradational density from rural to town core. Estimate build-out density of approximately 0.5 unit per acre gross, or 1.15 people/acre.

Existing Development (GPEX)
Existing lots ranging in size from 2 to 20 acres. Estimate average density of 1 unit per 10 acres gross, or 0.23 people/acre.

Rural West (GPRW)
Low density. Estimate 1 unit per 20 acres, or 0.12 people/acre.

Rural East (GPRE)
Low density. Estimate 1 unit per 20 acres, or 0.12 people/acre.

Hyalite Zoning District

Residential Existing RX (HRX)
Existing developments typically 1 unit per acre net, or .75 units per acre gross, or 1.73 people/acre.

Rural Residential RR-5 (HRR5)
One unit per 5 acres gross density, or 0.46 people/acre.

East Gallatin Zoning District

Commercial District CD (EGCD)
Light commercial uses. Estimate maximum density equivalent to 3 people/acre.

Neighborhood Commercial NC (EGNC)
Light commercial uses. Estimate maximum density equivalent to 2 people/acre.

Agricultural and Rural Residential AR (EGAR)
One unit per 20 acres, or one unit per 5 acres gross with CUP development. Estimate one unit per 5 acres gross density, or 0.46 people/acre.

Bridger Canyon

Agricultural Exclusive PD-10 (BCAE10)
Maximum density allowed is 10 acres per dwelling unit, or 0.23 people/acre.

Agricultural Exclusive PD-20 (BCAE20)
Maximum density allowed is 20 acres per dwelling unit, or 0.12 people/acre.

Recreation and Forestry PD-20 (BCRF20)
Maximum density allowed is 20 acres per dwelling unit, or 0.12 people/acre.

Wheatland Hills

Residential RS-1 (WHRS1)
Minimum lot size is 1 acre, or .75 units per acre gross, or 1.73 people/acre.

Zoning District 6

Residential Suburban RS-10
Minimum lot size is 10 acres, equivalent to 0.23 people/acre.

Middle Cottonwood

AR (outside Winter Range)
One lot per 20 acres, or 0.12 people/acre.

Unzoned Areas with or without Neighborhood Plans

Unzoned areas within the Bozeman Community Plan (UZBCP)
These areas are within the Bozeman Community Plan, but not within the Bozeman Area Zoning. Specifically these areas are located in the northeast and northwest corners of the Community Plan boundary. Build-out density in accordance with annexation into Bozeman with a net density of 6 units/acre at 2.3 people/unit. Estimate gross density of 3.5 unit/acre after roads, parks, etc removed. Gross density of 8 people/acre.

Unzoned Areas with Medium Density (UZMD)
Unzoned areas with existing development or undeveloped but located nearby existing development. Specifically these areas are located around existing subdivisions at the foot of the Bridger Range and Gallatin Range. Estimate a density similar to average of existing development of approximately 1 parcel per 2 acres, or 1.15 people/acre.

Unzoned Areas with Low Density (UZLD)
Unzoned areas that are not near an existing development node. Specifically this area is located between Bozeman, Four Corners and Gallatin Gateway. Estimate a density similar to existing development of approximately 20 acre parcels or 0.12 people/acre.

Projected Population Density Based on Zoning
Results of these future density allocations are summarized in table form in Table 3A-2 and shown graphically in Figure 3A-3, Study Area Build-out Density.

Table 3A-2 Study Area Build-out Populations	
	Build-out Population
Inclusive of Study Area Boundary	434,644
Excluded Areas within Study Area Boundary	174,982
Bozeman Municipal Area and enclosed GCZD 1 and GCBAZD lands	122,279
Rae WSD	5300
Belgrade Water Facility Plan Boundary	38,674
Four Corners WSD and areas served by Utility Solutions	7831
Gallatin Gateway WSD	897
Study Area	259,661
Within Bozeman Community Plan outside of Municipality	164,643
Other Areas with Build-out Density >2 people/acre	77,203
Other Areas with Build-out Density <2 people/acre	17,815

The results show that existing land use planning and zoning support growth throughout a core region of the study area. Areas outside of this core region are zoned or planned to have significantly lower build-out densities. Looking at the total population projected at build-out shows that at historical growth rates it will take 50-100 years to attain this density. However, it is important for planning purposes to project the extent and distribution of potential growth supported by existing land-use regulations.

Projected Population Density Based on Growth Rate and Term

In addition to zoning and planning designations the future population has been projected based on a growth rate applied over a term. For example to obtain a 20-year population of an area the existing population is increased by an annual growth rate for a period of 20-years. The downfalls of this method are that it does not consider spatial distributions encouraged by zoning and planning. Additionally, this method cannot effectively be applied to small areas with low existing population, with a growth favorable zoning designation. However, for the community as a whole this method is still useful in obtaining realistic future populations that can then be spatially distributed in accordance with zoning and planning designations.

For the period between 1990 and 2005 Gallatin County experienced an annual growth rate of 3% (Greater Bozeman Area Transportation Plan Update, 2007). While the spatial distribution of growth throughout the county since the 2000 census is not precisely known, the population within the study area has increased considerably. For the purposes of this study it is assumed that the growth rate within the study area and growth rate within the municipal areas excluded from the study area are equivalent.

NOTE: A 3% growth rate was applied to the entire existing population within the study area boundary. This allows for the fact that growth created by Bozeman and other excluded areas can affect the growth of nearby unincorporated areas within the study area. The results of this population projection are shown in Table 3A-3. The resulting 2030 population (20-years) within the study area will be approximately 59,388. Due to the recent zoning and planning efforts it is likely that most of this population growth will occur in the low population areas with growth favored zoning.

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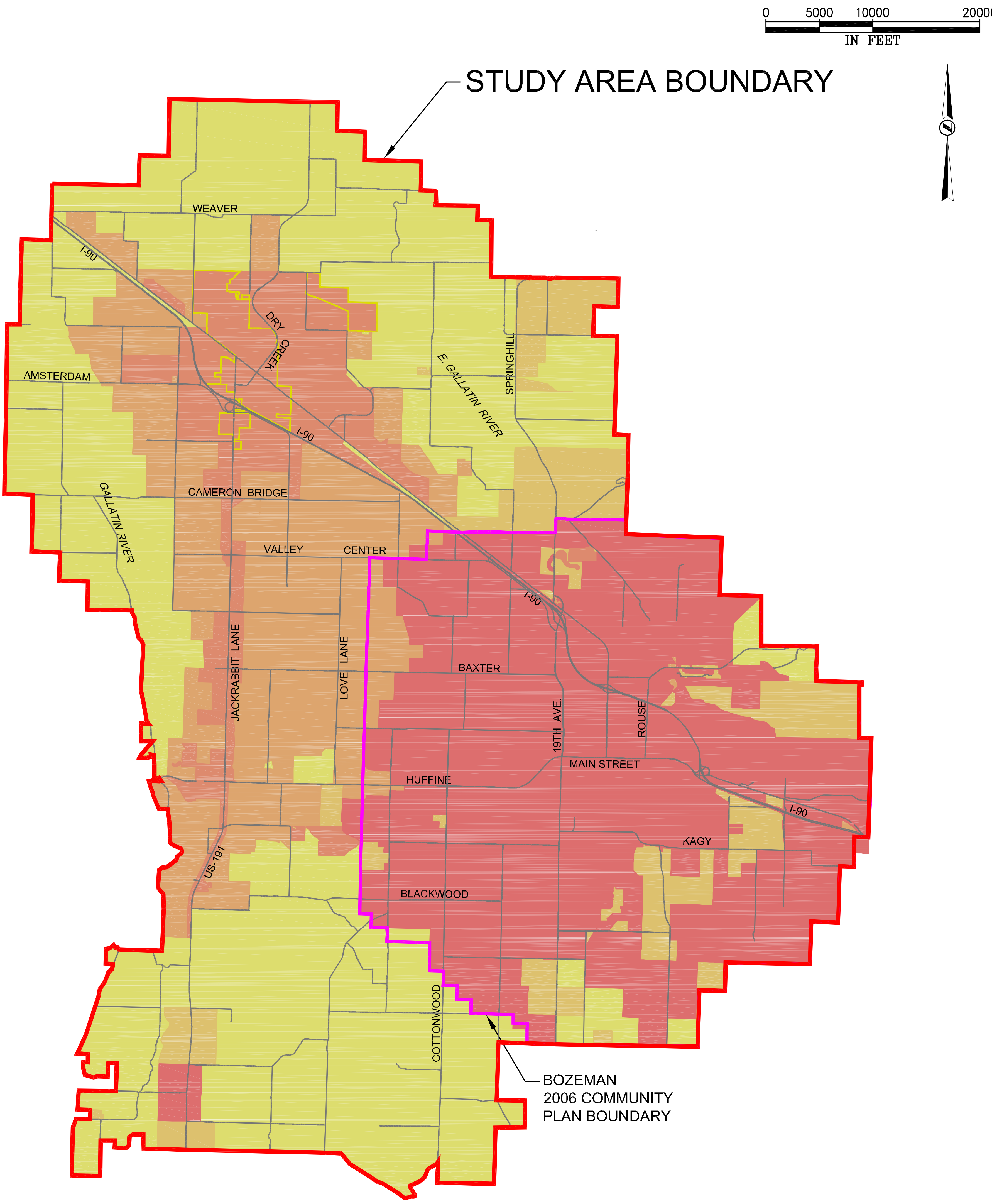

BUILD-OUT POPULATION DENSITY

- 0.0 TO 0.5 PEO/AC
- 0.5 TO 2.0 PEO/AC
- 2.0 TO 4.0 PEO/AC
- 4.0 TO 6.0 PEO/AC
- 6.0+ PEO/AC

NOTES:

1. GIS DATA SUPPLIED BY GALLATIN COUNTY GIS DEPARTMENT VIA GALLATIN COUNTY PLANNING DEPARTMENT. SHOWN IN MONTANA STATE PLANE (FEET).

2. BUILD-OUT DEVELOPMENT DENSITY IS ESTIMATED FROM LOT DENSITY OR SIZE REQUIREMENTS OF EXISTING OR PROPOSED ZONING REGULATIONS AND PLANNING DOCUMENTS.

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FIG. 3A-3

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STUDY AREA BUILD-OUT DENSITY

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Table 3A-3 Study Area 2030 Populations	
	Est. 2030 Population
Inclusive of Study Area Boundary	128,252
Excluded Areas within Study Area Boundary	68,864
Bozeman Municipal Area and enclosed GCZD 1 and GCBAZD lands	51,267
Rae WSD	1,588
Belgrade Water Facility Plan Boundary	13,410
Four Corners WSD and areas served by Utility Solutions	2,301
Gallatin Gateway WSD	298
Study Area	59,388
Within Bozeman Community Plan outside of Municipality	30,140
Other Areas with Build-out Density >2 peo/acre	21,281
Other Areas with Build-out Density <2 peo/acre	7,967

Overview of Existing, 2030 and Build-out Population Distributions.

The previous population and growth analysis provides insight towards the potential distribution of future population within the study area. Figures 3A-4, 3A-5, and 3A-6 show the population distribution by general category relative to each other and build-out.

These figures compare the existing (2010), 2030, and Build-out populations relative to each other, with the size of the pie distribution relative to the build-out populations. The underlying purpose of this population growth and distribution analysis is to allow study focus on areas with the greatest potential benefit to the most people. These figures show clearly that most of the population growth in the study area will be within the Bozeman Municipality or within the Bozeman Community Plan Boundary. The second largest growth area within the study area will be within portions of the study are that are zoned for higher density growth (>2 people/acre). The portion within the Belgrade Facility Plan will also represent another high growth area. Portions of the study area with lower density zoning will not be a significant portion of the future populations.

Figure 3A-4. 2010 Population Distribution

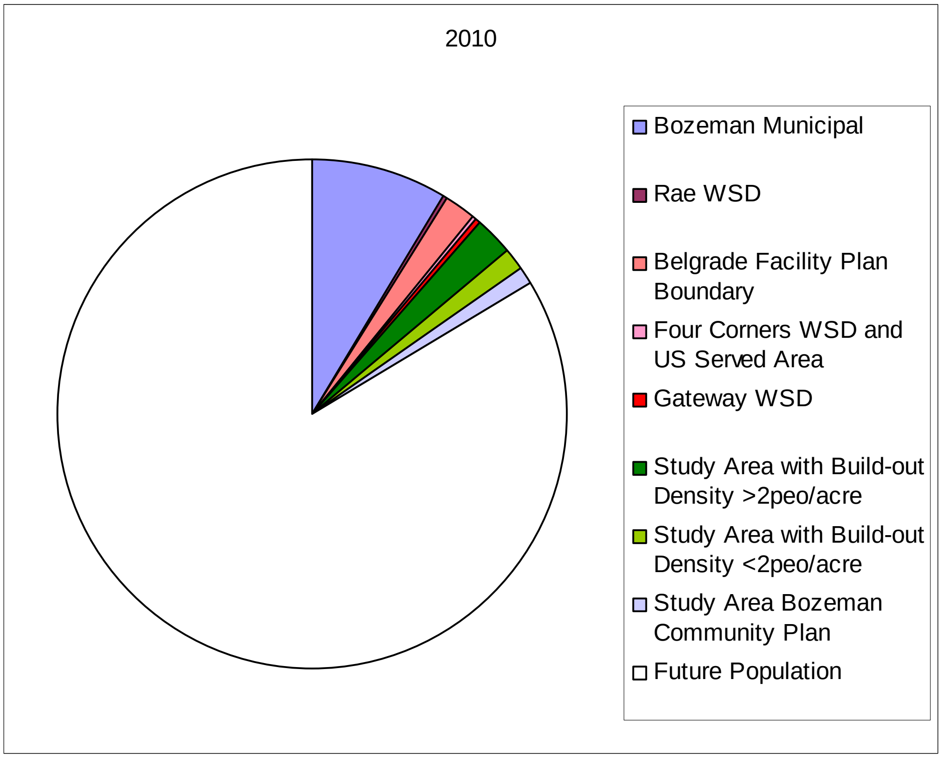


Figure 3A-5. 2030 Population Distribution

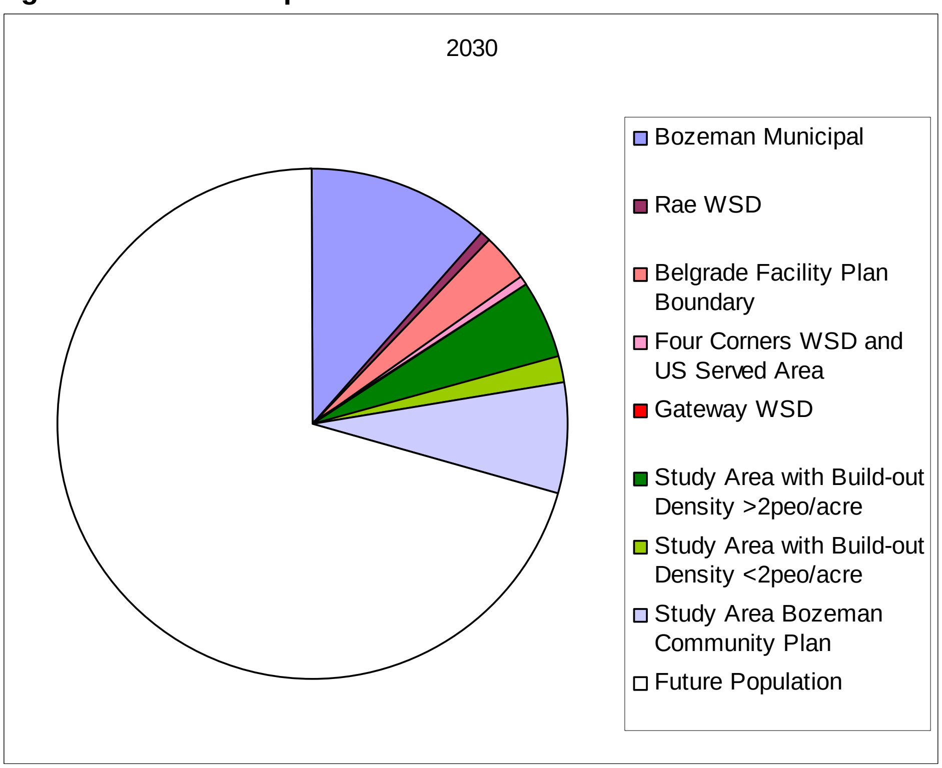
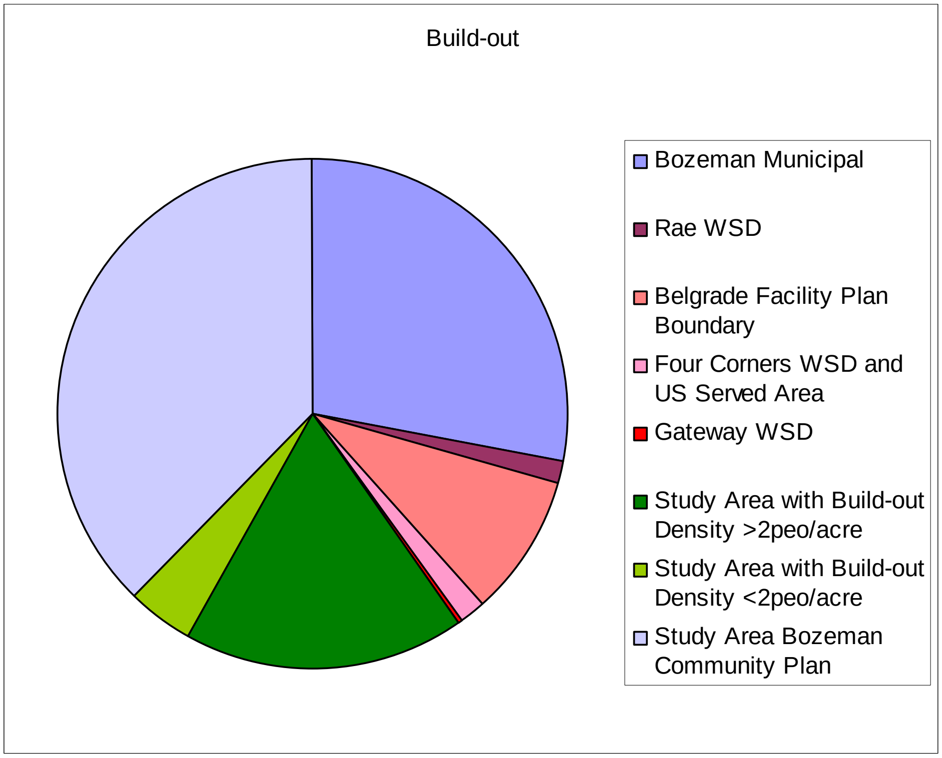


Figure 3A-6. Build-out Population Distribution



SECTION B
CONSTRAINTS ANALYSIS

1. OVERVIEW OF EXISTING LAWS AND REGULATIONS

LAWS

Wastewater treatment facilities are regulated under both state and federal laws. Practically speaking, the federal regulations are enforced through state agencies, in this case Montana DEQ, which has been delegated primary enforcement authority. For this project, the following statutes apply:

- U.S. Clean Water Act; PL 92-500, PL 95-217, PL 97-117, PL 100-4, (Federal Authority),
- Montana Water Quality Act; 75-5-101 through 641, MCA (State Authority),
- Public Water Supply Act; 75-6-01 through 121 MCA (State Water and Wastewater Design Standards), and
- Sanitation in Subdivisions Act; 76-4-101 through 131, MCA (State Authority).

<u>Montana Water Quality Act</u>
Under the authority of this law and associated rules, the state establishes surface water quality standards based on beneficial uses and existing water quality; implements the non-degradation policy; issues surface water discharge permits; implements a groundwater protection program; conducts inspections of wastewater facilities; and generally prohibits pollution of state waters. The law applies to both surface water and groundwater.

Any discharge to ground water is required to meet Montana Water Quality non-degradation rules. In general, the non-degradation rules establish annual average load limits (lb/day) for BOD_5, TSS, total inorganic nitrogen, inorganic phosphorus, fecal coli form, and chlorine residual. For existing discharges, these loads would be based on the approved system design criteria and permit limits in effect on April 29, 1993.

<u>Montana Public Water Supply Act</u>
The Montana Public Water Supply Act establishes design standards for public water and wastewater equipment and processes. The law requires DEQ to review and approve all plans and specification for wastewater facilities prior to construction. Upon completion of the construction of water and wastewater systems, the owner must certify to DEQ that the facilities were constructed in conformance with DEQ-approved plans. The law also authorizes the DEQ to inspect water and wastewater systems periodically (typically every five years) to ensure conformance with public health, sanitary and design standards. The state design standards that apply to this project and that are enforced under this law are described in DEQ Circulars DEQ 2, DEQ 4, and DEQ 5.

<u>Sanitation in Subdivisions Act</u>
The Sanitation in Subdivisions Act pertains to water supply, wastewater treatment, solid waste, and storm drainage facilities within a subdivision. This act also provides for requirements, criteria, and standards for sub-surface disposal of wastewater. The state design standards that apply to this project and that are enforced under this law are described in DEQ Circular DEQ 4.

REGULATIONS

Montana Department of Environmental Quality (MDEQ) is responsible for reviewing, and enforcing compliance of wastewater treatment systems. MDEQ has created rules, regulations, and Department Circulars in conformance with the previously mentioned laws.

Public Water and Sewer System Requirements are provided by ARM Rule 17, Chapter 38. Water Quality regulations (ARM Rule 17, Chapter 30) apply to the discharge of wastewater from a treatment plant. Subdivisions/On-site Subsurface Wastewater Treatment regulations (ARM Rule 17, Chapter 36) apply to subsurface disposal of wastewater.

MDEQ has written Department Circulars providing standards for wastewater treatment systems and water quality standards. Department Circular DEQ-2 applies to large wastewater treatment facilities. Department Circular DEQ-4 applies to wastewater treatment using sub-surface disposal. Department Circular DEQ-7 provides Montana water quality standards.

Large wastewater discharges must obtain a permit to discharge treated water. Montana Pollution Discharge Elimination System (MPDES) permits are required for point source discharges to state waters. Montana Ground Water Pollution Control System MPGWPCS permits are required for discharges to groundwater. These discharge permits require monitoring, reporting, and periodic renewal to ensure present and future water quality standards are met.

Water quality impacts are regulated at the outlet of a “mixing zone”. A mixing zone is defined as a “limited area of a surface water body or a portion of an aquifer, where initial dilution of a discharge takes place and where water quality changes may occur and where certain water quality standards may be exceeded”. A large mixing zone allows for greater dilution and is less restrictive, and a small mixing zone reduces allowable dilution and is more restrictive.

Water quality impacts to surface and groundwater are regulated separately. If the mixing zone from a groundwater discharge intersects a surface water, then impacts to the surface water quality must be assessed in addition to groundwater. Surface water quality standards tend to be more stringent than groundwater quality standards. Discharges to groundwater that MDEQ feels will impact surface water quality (regardless of absence of surface water in the mixing zone) must meet the surface water quality standards. There is no statutory guidance to assist in the determination of when a groundwater discharge must meet surface water quality standards if the surface water is outside of the mixing zone. Due to the regulatory framework and methodology used in water quality assessment, wastewater systems discharging to groundwater typically cannot meet the surface water standards in nearby streams.

2. GROUNDWATER DISCHARGE CONSTRAINTS

There are numerous constraints relative to groundwater discharging alternatives. Specific constraints to groundwater discharging alternatives have been evaluated with the study area. The following constraints are used to evaluate potential discharge sites and will dictate the potential requirements of the disposal site.

- Depth to groundwater.
- Allowable soil hydraulic loading rates.
- Proximity to down-gradient public and individual water supply wells.
- Potential for groundwater mounding in the aquifer.
- Distance to surface water and Non-degradation.
- Availability of undeveloped land.

Figure 3B-1 Groundwater Disposal Constraints Map shows the spatial distribution of the major constrains to groundwater disposal. Each of the constraints is described in detail in the following section.

Depth to Groundwater

Regulations require at least 4 feet of vertical separation between a wastewater discharge and seasonal high groundwater (6-foot depth to groundwater). Soil Survey data was used to identify areas within the Study Area with shallow depth to groundwater. Much of the Study Area has depths to seasonal high groundwater less than 200 cm or about 6 feet (the limit of the Soil Survey data). Figure 3B-1 shows the geographic distribution of seasonal high groundwater depths greater than 6 feet, within the study area. Areas with depths to groundwater less than 6 feet are not suitable for larger groundwater disposal systems.

Greater depth to groundwater (beyond 6 feet) is favorable, as it allows increased treatment between the disposal and the aquifer. Additionally, a greater depth to groundwater can accommodate potential groundwater mounding below the disposal area. Ideally, a depth to groundwater of 10-20 feet is most desirable. Data for spatial distribution of groundwater depths greater than 6' was not available. Further detailed site investigation is required to determine actual depth to groundwater at a potential disposal site. Qualitatively, the areas with the greatest depth to groundwater within the study area are east of Gallatin Gateway, the Bridger Bench, Valley Center Bench, and the area around Belgrade.

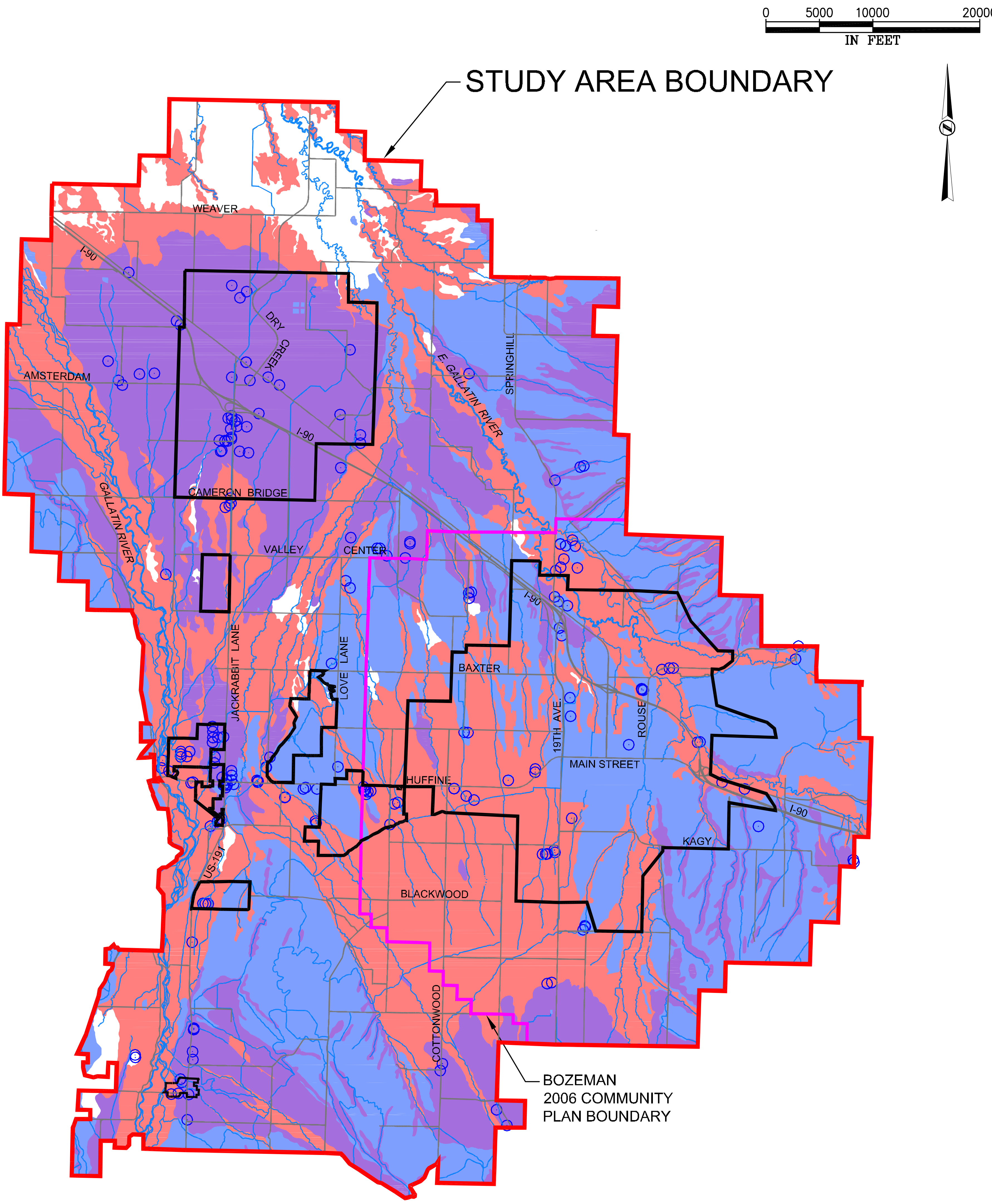
Allowable Soil Hydraulic Loading Rates

With a typical on-site (septic) system the soil provides treatment of the wastewater. In such systems lower permeability soils provide greater retention time in the soil and superior treatment. If the waste is treated to a high degree prior to groundwater discharge, treatment in the soil is less critical. In these systems, the allowable soil hydraulic loading rate determines the overall footprint of the disposal area, and areas with higher permeability soils are more favorable.

Smaller systems, due to their low land requirements, can accommodate lower permeability soils simply by making the disposal area larger. With large systems the additional land requirements are more costly. Therefore, for a large system disposing of highly treated wastewater the allowable soil hydraulic loading rate is an important constraint. A more permeable soil will also allow treated wastewater to disperse into the aquifer more rapidly, and reduce groundwater mounding potential.

Soil survey data for the saturated hydraulic conductivity was used to determine areas with suitable hydraulic loading rates. The desired disposal rate is 1.0 gallon per sq ft per day. Although there is not a direct correlation between hydraulic conductivity and allowable loading rate, a hydraulic conductivity of >12 um(micrometers)/second should provide sufficient permeability to allow the desired disposal rate. Figure 3B-1 shows areas with suitable hydraulic conductivity, and thus suitable loading rate. This constraint mapping shows that the soils with favorable conductivity are located in the alluvial gravels between the West Gallatin River and Hyalite Creek.

N:\0939-01809 GALLATIN COUNTY WW STUDY PH2\dwg\Figures\Fig -3B-1 Study Area Disposal Constraints.dwg, FIG- DISPOSAL, Plotted: Sep 15, 2010 - 2:03pm, brickert



KEY

- AREAS WITH >6' TO GROUNDWATER
- AREA WITH FAVORABLE HYDRAULIC CONDUCTIVITY
- AREAS WITH BOTH >6' TO GROUNDWATER AND FAVORABLE HYDRAULIC CONDUCTIVITY
- AREAS WITH BOTH <6' TO GROUNDWATER AND UNFAVORABLE HYDRAULIC CONDUCTIVITY
- PUBLIC WELL WITH 500' RADIUS

NOTES:

1. GIS DATA SUPPLIED BY GALLATIN COUNTY GIS DEPARTMENT VIA GALLATIN COUNTY PLANNING DEPARTMENT. SHOWN IN MONTANA STATE PLANE (FEET).

2. SOIL DATA IS FROM NRCS SURGO DATA AND NASIS DATABASE.

3. WELL DATA IS FROM GALLATIN COUNTY LOCAL WATER QUALITY DISTRICT.

WORKING DRAFT REPORT

FIG. 3B-1

SHEET

DESIGNED CDP
DRAWN BAR/CDP
CHECKED RMS
DATE 9/15/2010

STUDY AREA DISPOSAL CONSTRAINTS

REGIONAL WASTEWATER TREATMENT FEASIBILITY STUDY, PHASE 2
GALLATIN COUNTY, MONTANA

ISSUE			
No.	DATE	DESCRIPTION	BY
1	JULY, 2010	WORKING DRAFT REPORT	BAR
2	9-17-2010	WORKING DRAFT REPORT	BAR

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Proximity to Down-Gradient Water Supply Wells

There are numerous public and individual water supply wells in the Study Area. For the purposes of the constraints identification, only public wells were considered. The basis for this simplification is that individual wells could be moved easier, and may be abandoned in the future if public water supply becomes available.

Figure 3B-1, the constraints map, shows the location of public wells as provided by the Gallatin County Health Department and MDEQ. The well symbol represents a 500-foot radius from the well. However, regulations require that a mixing zone not intersect the zone of influence of a water supply well. Each well can have a unique zone of influence with higher flow wells have a larger zone of influence. The zone of influence also extends further up-gradient than down-gradient. The 500-foot radius symbol shown is typically suitable for all setbacks except for up-gradient of the larger community supply wells. A large disposal field may need to be up to 1 mile up-gradient of a large community supply well.

The spatial distribution of public supply wells show that there are public supply wells for larger community systems and subdivisions such as Belgrade, River Rock, Valley Grove, Wylie Creek, Utility Solutions, Elk Grove, Rae WSD, etc. There are also smaller public supply wells serving commercial uses outside of areas served by community water systems. These wells are common in locations such as outside of Belgrade, Four Corners, along Huffine Lane and in unincorporated areas near Bozeman. Keeping in mind that groundwater typically flows from south to north, this constraint favors disposal areas north (down-gradient) of Belgrade.

Potential for Groundwater Mounding in the Aquifer

Groundwater mounding occurs in the aquifer below all large groundwater disposal areas. Typically, groundwater mounding is greater in low permeability non-alluvial aquifers. Areas with suitable hydraulic conductivity and sufficient depth to groundwater can accommodate groundwater mounding in the aquifer without detrimental impacts. If hydraulic conductivity or depth to groundwater is not sufficient, loading rates have to be decreased or the overall footprint increased.

Distance to Surface Water and Non-degradation

Figure 3B-1, the constraints map, shows there are numerous streams and large irrigation ditches within the study area. Even though proposed disposal is to the groundwater, the ultimate destination is down-gradient surface water. Increased distance to surface water allows for wider dispersion and greater mixing of the treated wastewater and groundwater, reducing impacts to down-gradient surface water. At a minimum any disposal site would need to be greater than 500 feet up-gradient of a stream, so the mixing zone does not intersect surface water. MDEQ rules and regulations for addressing surface water impacts due to large-scale groundwater disposal allow a large degree of latitude in their interpretation, especially if surface water is nearby. Therefore, favorability of a disposal site increases with distance to surface water.

Water quality regulations require that any discharge not cause degradation of water quality (commonly referred to as Non-degradation). More precisely MDEQ reviews the discharge to determine if there is a “significant” degradation. Significance occurs if trigger values of the water quality parameter are exceeded at the down-gradient end of the mixing zone. DEQ Circular-7 is a document that contains numeric water quality standards and trigger values for a variety of pollutants found in treated effluent of which important parameters are nitrogen and phosphorous. The trigger values for nitrate in groundwater are 5.0 mg/l for conventional septic systems, and 7.5 mg/l for systems that remove >60% of the nitrogen from the waste stream. Phosphorus is evaluated as a breakthrough analysis. This analysis assumes that phosphorus is retained in the soil until the soil reaches its capacity, then phosphorus “breaks through”. Nondegradation requires that phosphorus retention capacity be at least 50 years.

Applying these standards as groundwater disposal constraints is as follows. For small discharges, nitrate is diluted to below the trigger value in the mixing zone by the much greater natural groundwater flow. However, large discharges require a very large groundwater flow for significant dilution. The hydraulic conductivity constraint identifies areas with greater dilution potential. However, there is not enough groundwater flow even in these areas to dilute large discharges. The absence of significant dilution in the mixing zone requires the total nitrogen in the discharge to be less than the trigger value of 7.5 mg/l for large systems. The phosphorus breakthrough soil retention increases with depth to groundwater and distance to surface water. For a large 4MGD treatment facility to meet the 50-year retention criteria with a depth to groundwater of 10 feet and a distance to surface water of 5000 feet requires phosphorus reduction to 2.5 mg/l (75%). Greater depth to groundwater and distance to surface water would require less phosphorus removal by the treatment plant.

Availability of Undeveloped Land

In order to be practicable, any disposal site will require a significant tract of undeveloped land. With continued growth in the suburban areas, the potential for a suitably sized parcel are decreasing. The selected disposal site should encompass suitable area to accommodate the treatment system, disposal area, plus room for a 500-foot mixing zone.

3. RIVER DISCHARGE CONSTRAINTS

There are significant constraints relative to the river discharge of treated effluent. Although the scope of work defines groundwater discharge as the primary disposal mechanism, this summary is provided in the event that any future reader of this report wonders why river discharging alternatives were not included. In addition, some groundwater discharges, depending on their characteristics, volume, and location, may be considered by regulatory agencies as impacting surface waters. As a result, a review of this information may useful in future study phases.

East Gallatin River

Montana rules and regulations do not allow surface waters to be degraded by pollutant discharges. DEQ Circular-7 is a document that contains numeric water quality standards for a variety of pollutants found in treated effluent of which important parameters are nitrogen and phosphorous. Trigger limits for these compounds contained in Circular-7 are extremely low and cannot be exceeded. The non-degradation trigger limit for total nitrogen is 0.01 mg/l and 0.001 mg/l for phosphorous. The calculation uses a mass balance on the East Gallatin’s 10 year low flow condition (known as the 7Q10 Flow) of 14.9 million gallons per day to estimate the allowable nitrogen and phosphorous discharge from a central facility.

The resulting discharge estimates are quite low. Figure 3B-2 is a graph of the allowable effluent total nitrogen and phosphorous concentration versus discharge flow rate. As shown in the plot, treatment levels must increase as the flow increases to maintain compliance with the non-degradation standards. This graph is illustrative of the problems facing any centralized treatment facility attempting to discharge to surface water. As flows are combined from various regions and discharged as a point source, the level of treatment quickly rises to a point that is technologically impossible. For the East Gallatin example, 200,000 gallons per day likely represents a practical upper limit for discharge.

The reader should be aware that a host of other water quality limits and requirements exist or are in the planning stages. However, the analysis presented here likely represents the most restrictive conditions at this point in time. As a result, a detailed analysis of other possible restrictions is not necessary for this report.

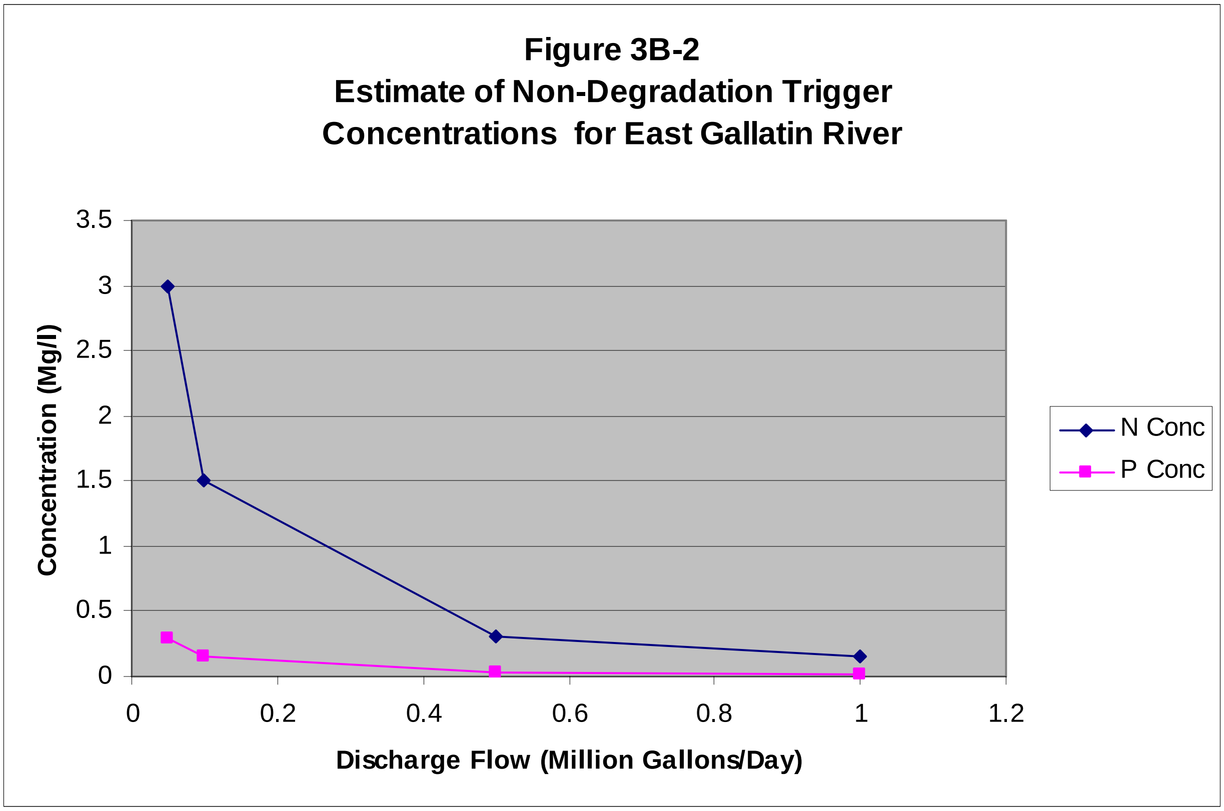


Figure 3B-2
Estimate of Non-Degradation Trigger Concentrations for East Gallatin River
Concentration (Mg/l)
3.5
3
2.5
2
1.5
1
0.5
0
0
0.2
0.4
0.6
0.8
1
1.2
Discharge Flow (Million Gallons/Day)
N Conc
P Conc

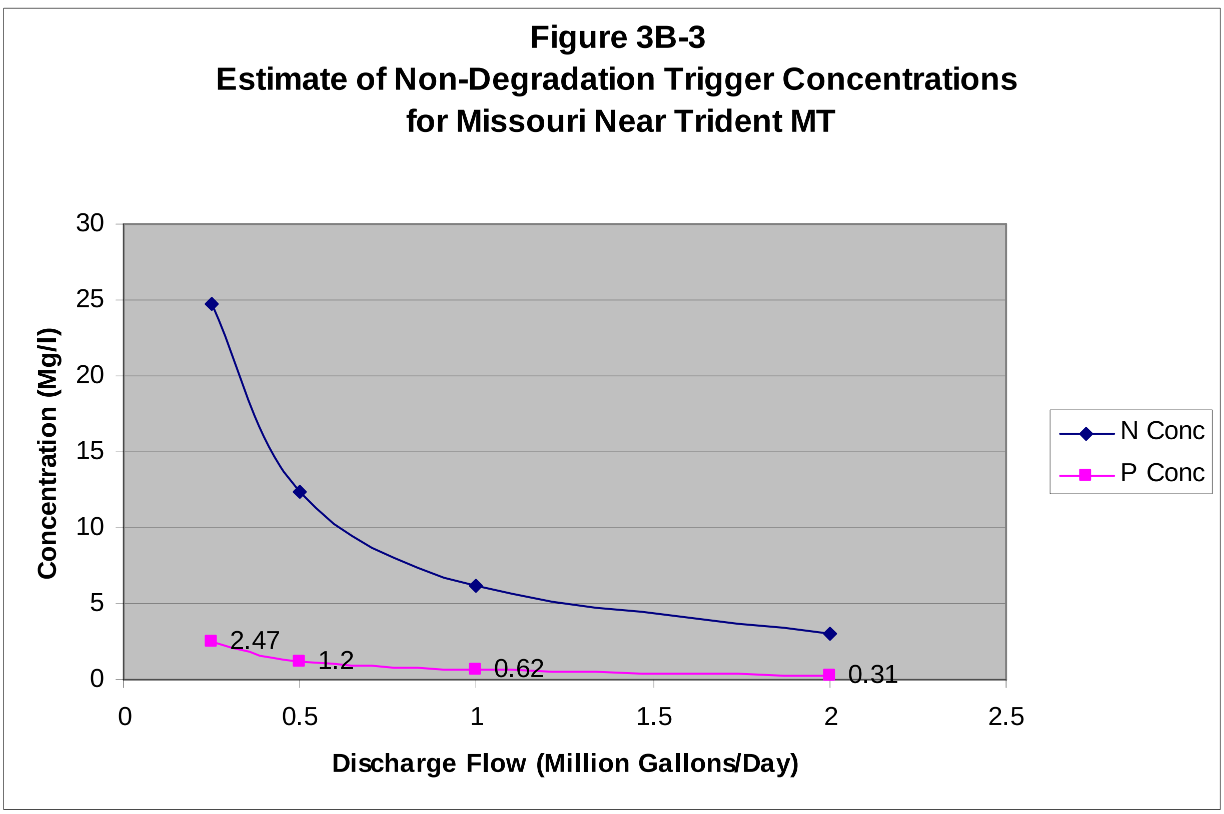


Figure 3B-3
Estimate of Non-Degradation Trigger Concentrations for Missouri Near Trident MT
Concentration (Mg/l)
30
25
20
15
10
5
0
2.47
1.2
0.62
0.31
0
0.5
1
1.5
2
2.5
Discharge Flow (Million Gallons/Day)
N Conc
P Conc

Missouri River at Three Forks

The public has requested that hydropower generation with treated effluent be investigated. The scope of work specifies that this evaluation assume a Missouri River discharge point located in the vicinity of Trident Montana. In this case, an identical calculation is performed using the 7Q10 low flow for the Missouri River at the closest gauging station located at Toston. Because the Missouri has a significantly higher 7Q-10 flow (619 Million gallons per day), higher discharge concentrations may be possible. Figure 3B-3 is a graph of the estimated total nitrogen and phosphorous concentration versus discharge flow rate. As shown in the plot, treatment levels must increase as the flow increases to maintain compliance with the non-degradation standards. This graph is again illustrative of the problems facing any centralized treatment facility attempting to discharge to surface water. As flows are combined from various regions and discharged as a point source, the required level of treatment quickly rises; for this example, about 1 to 2 million gallons per day may represent the maximum allowable discharge flow.

4. WATER RIGHTS CONSTRAINTS

Water rights are not commonly considered as a wastewater treatment constraint, but recent regulatory changes make them so. Water rights statutes and regulations require that adverse impacts on existing water users be mitigated. This applies to both existing groundwater and surface water users. Essentially, mitigation is required to reduce effects on the existing hydrological regime that could be caused by a new water diversion. Mitigation is only required for new water rights, obtained after 2003 So this will apply to any new development within the study area utilizing a community water system. And, since a regional system would serve primarily new development, mitigation requirements will apply to most of the users of a regional system.

An example of how this affects wastewater disposal is as follows. When groundwater or surface water is used to supply community drinking water systems new or additional water rights have to be obtained. Water is diverted from the ground or surface and piped to residents and then collected in sewers and piped to a treatment and disposal area. This water is not available to other water users located between the water supply diversion and the wastewater disposal area.

A key component of typical mitigation plans is a return of treated wastewater to the river or aquifer after use. With this return flow, only the evaporative losses have to be mitigated. For wastewater return to be considered as a mitigation component, the return must be fairly close to the diversion.

Within a small community system for a single subdivision, the water supply wells and wastewater disposal areas are typically within the subdivision, and thus not very far apart. However, if the wastewater is collected and treated in a central system, the wastewater disposal area may be several miles from the community's water supply wells.

A logical conclusion is that for a centralized wastewater treatment system to be feasible, a regional water supply with wells in fairly close proximity to the regional disposal is also required. Accordingly the regional water supply can then utilize the regional wastewater return as part of its mitigation requirements. Furthermore, as a regional wastewater system grows to absorb existing community systems, the community's water supply and water rights would have to be absorbed by a regional water supply. This would involve moving the water supply and water rights to the regional water system's supply wells. Mitigation to offset landscape irrigation will be still required at each new development, in proportion to the irrigation requirements of the development. This mitigation is separated from wastewater return mitigation, due to its seasonal use and on-site application.

Due to the complexity of water rights constraints on new development, an attorney specializing in water rights was a key team member. His explanation and assessment is included in Appendix B.

Water rights constraints also factor in to the type of wastewater treatment alternatives that are available for a regional system. For example, land application of treated wastewater by irrigation is a consumptive treatment method, as the wastewater disposal is by evaporation. This consumptive use will need to be offset by a large year-round mitigation from the water supply. Since historical year-round uses are limited, water is not available for mitigation. This essentially renders land application of treated wastewater unfeasible at a regional scale.

Likewise, water rights constraints also affect the potential for treated wastewater to be discharged further downstream at Trident for the production of hydro-power in the discharge. This large distance between withdrawal and disposal, would require unfeasible levels of mitigation.

SECTION C
OVERVIEW OF DECENTRALIZED WASTEWATER TREATMENT TECHNOLOGIES & ECONOMICS

1. OVERVIEW

Decentralized wastewater treatment systems provide localized sewage treatment and disposal to individual residences, clusters of residences, and smaller commercial structures that emit residential strength wastes. In Montana decentralized (non-public) wastewater systems are defined as having fewer than 25 persons or 15 service connections whichever is less. Because service is often limited to a small number of connections, extensive collection facilities such as gravity sewers and lift stations are typically not present to any great degree. Approximately one in four persons is serviced by a decentralized system in the United States. Compared to centralized facilities, decentralized facilities also:

- Are smaller and less complicated than central systems,
- Are usually not staffed or partially staffed,
- Are typically un-permitted and unmonitored,
- Have a higher true economic cost,
- Produce a lower quality, more variable effluent.

2. DECENTRALIZED SYSTEM REVIEW

The scope of work for this project requires that decentralized facilities be classified according to several criteria including their cost, degree of treatment, ease of upgrade to higher levels, status under Montana regulations, range of loads efficiently and economically served, land area required, and where practicable the adjustments to those facilities that would allow the appropriate treatment of commercial and/or industrial wastes. Figure 3C-1 provides simplified block flow diagrams and comparative information for several types of decentralized wastewater treatment systems. Referring to this figure, the universe of available systems has been organized into 3 general groups ranging from basic septic systems to the more complex systems such as packed bed filters. A generalized discussion of each system type is provided below:

2.1 Group 1 Systems

<u>Overview</u>

Group 1 systems include conventional septic tanks and drain fields. Primary treatment occurs in the septic tank after which the effluent is disposed in absorption trenches.

Depending on site conditions and regulatory requirements, the absorption drain field may be gravity flow or pressurized. Because the pressurized drain field provides a more uniform application of the effluent to the disposal site there is less tendency for plugging and system failure making pressure drain fields a superior alternative to gravity systems.

Figure 3C-1
Decentralized Wastewater Treatment System Examples
Typical Single Family Application (230 Gal/Day)

Category	Primary Treatment	Secondary Treatment	Tertiary Treatment	Disposal Method	Approximate Initial Cost $/Connection	Approximate Initial Cost $/Gal of Capacity	True Economic Cost $/Connection-Year	Expected Effluent Quality Mg/L of Total N	Pharmaceutical Compound Destruction ?	Relative Operational Complexity	Sludge Production ?	Appendix References
Group 1 Systems	Septic Tank			Gravity Soil Absorption System	$11,000	$48	$1,900	50	No	Low	From Septic Tank Pumpout	C through L
	Septic Tank			Pressure Soil Absorption System	$12,000	$52	$2,200	50	No	Low	From Septic Tank Pumpout	C through L
Group 2 Systems	Septic Tank	Intermittant Media Filter		Gravity or Pressure Soil Absorption System	$20,000	$87	$3,300	30 to 40	No	Medium	From Septic Tank Pumpout, Media Cleaning	C through L
	Septic Tank	Recirculating Media Filter		Gravity or Pressure Soil Absorption System	$28,500	$124	$4,700	24 to 30	No	High	From Septic Tank Pumpout, Media Cleaning	C through L
Group 3 Systems (Experimental)	Septic Tank	Recirculating Media Filter	Packed Bed Unit w/ Methanol Addition	Gravity or Pressure Soil Absorption System	$35,000	$152	$5,400	<24	No	High	From Septic Tank Pumpout, Media Cleaning	C through L,T
	Septic Tank	Recirculating Media Filter	Packed Bed Unit w/ Methonol Addition; Filtration UV Light + Peroxide	Gravity or Pressure Soil Absorption System	$50,000	$217	$7,700	<24	Yes	Untenable for Small Flows	From Septic Tank Pumpout, Media Cleaning, and Filtration	C through L, M,T

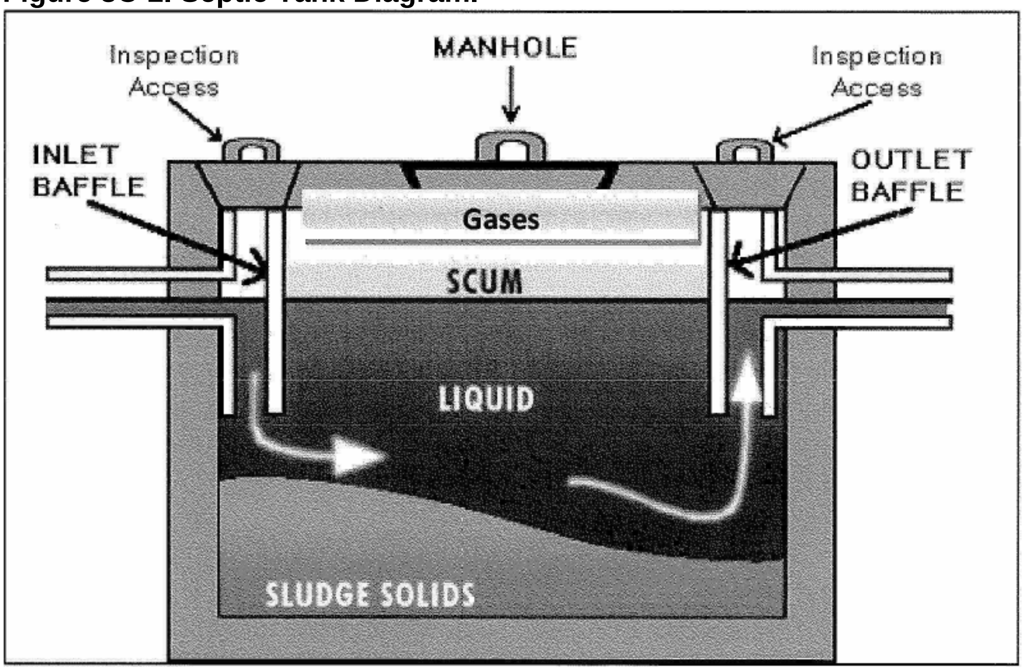
Key
Approved in Montana
Not Approved for This Application

Septic Tank Process Description

A simplified diagram of a septic tank is shown in Figure 3C-2. As shown, incoming wastewater enters the tank through a baffle structure designed to reduce the turbulence inside the tank. Under quiescent conditions, the solids settle to the bottom and the fats oils and greases accumulate on the surface. The floating layer is often known as a scum layer. The liquid layer that forms above the sludge layer and below the scum layer is called the effluent. The effluent either flows by gravity or is pumped to the absorption drain field for disposal. Other than regular maintenance to prevent the over-accumulation of sludge and scum, the septic system typically operates without operator attention.

The waste treatment process within a septic tank is incomplete meaning that the effluent still contains a substantial quantity of suspended and dissolved solids, organic matter, and nitrogen compounds. Typical septic tank biological oxygen demand (BOD) removal efficiencies are 30-50%. They also remove about 60-80% of the settleable solids, oils, greases, and floating debris. Expected effluent nitrate concentrations are about 50 mg/l and are considered a poor level of treatment. Septic tanks also do not provide for good removal of chlorides, viruses, toxic organic, and endocrine disrupting compounds (EPA/625/R-00/008 Feb 2002).

Figure 3C-2. Septic Tank Diagram.



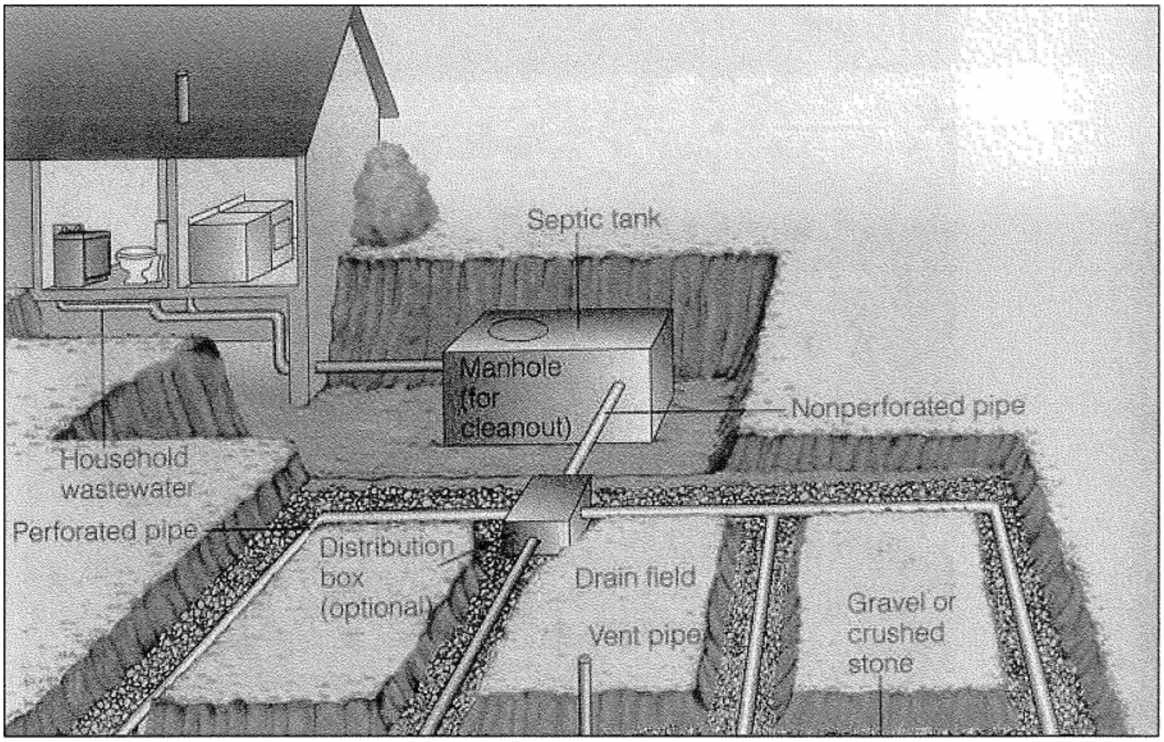
Raw wastewater entering a septic tank encounters quiescent conditions that allow solids to separate from the liquid waste. Heavy solids settle to the bottom to form sludge, floating solids form a scum layer, and the remaining partially treated wastewater flows out of the tank to the disposal structure.

Absorption System Process Description

Figure 3C-3 shows a typical septic tank and a gravity soil absorption (drain field) system. As shown, effluent from the septic tank flows to a distribution or splitter box that evenly divides the flow to each drain field lateral. Laterals consist of a perforated PVC pipe installed in a gravel lined trench. After application, the effluent percolates into the subsurface and typically mixes with groundwater and flows away from the application site. In certain dry locations, the effluent eventually dissipates within the soil profile. Although some additional filtering and limited treatment of the effluent likely occurs during the disposal process, results would be very site specific. Because these systems are not usually monitored, it's not possible to predict what level of additional treatment, if any, occurs.

Inadequate distribution is a common problem with gravity-feed drain fields. Common causes would include a lack of a distribution box or a box that is not level. Settling of the septic tank, distribution box, and drain field laterals with time is the most common cause of distribution problems. When this condition occurs, portions of the drain field become hydraulically overloaded resulting in a host of problems including plugging, clogging, and surface discharge of effluent.

Figure 3C-3. Diagram of a Conventional Septic Tank and Gravity Drainfield with Distribution Box.



The pressure soil absorption system was developed in response to the distribution problems associated with conventional gravity systems. In this case the distribution box shown above is replaced with a dosing chamber containing a pump or pumps. A timer, or float control switch, periodically turns on the pump(s) which feed the laterals. Distribution valves can also be used to pressurize the laterals one at a time. By pressurizing the laterals, a more even distribution of flow is achieved. This configuration often results in less maintenance and a longer drain field life.

Elevated sand mounds (ESM) are sometimes used instead of gravity or pressure drain fields in areas where restrictive site conditions such as shallow bedrock, high ground water exist. ESM's are constructed above grade to achieve the minimum separation (typically four feet) to the seasonally high groundwater level or to a confining layer such as bedrock. This technology is considered the disposal component of a Group 1 system.

Cost

For discussion and planning purposes, the capital cost of Group 1 systems is expected to range from about $11,000 to $12,000 for a typical home having 2.3 occupants and a flow rate of 230 gallons per day. The higher value represents the added cost of the pressure dosing equipment. Cost figures are total costs and include site evaluations, engineering and permitting as well as system installation. The installed cost of these systems expressed in terms of dollars per gallon of treatment capacity ranges from $44/Gallon of capacity to $52/gallon of capacity.

The true economic cost was also determined for these systems. The true economic cost takes the capital, operation and maintenance, and land costs and spreads them over a 20 year time frame with an assumed interest rate of seven percent. Twenty years was selected based on the assumption that a "typical" system lasts about 20 years. Based on this analysis, the true economic cost for Group 1 systems ranges from about $1900 to $2200 per year for the typical single family structure with 2.3 occupants. These costs are conservative in that replacement drainfield costs are not included. Appendix S contains the economic analysis of these systems.

Comparative Degree of Treatment Obtained

Group 1 systems offer the lowest levels of treatment among all types of decentralized treatment technologies. From the standpoint of protecting groundwater quality, these systems are expected to produce an effluent total nitrogen concentration of about 50 mg/l offering little if any protection of groundwater quality. A summary of the expected septic tank effluent composition is provided in Table 3C-1 below.

Table 3C-1
Group 1 Treatment Systems
Expected Septic Tank Effluent Composition

Parameter	Value
Biochemical Oxygen demand	125 Mg/l or greater
Total Suspended Solids, Oil & Grease	50 Mg/l or greater
Total Nitrogen	50 Mg/l
Pharmaceutical Compounds	No Removal

Ease of Upgrade to Higher Levels

As shown in Figure 3C-3 (previous), Group 1, 2, and 3 systems all share the septic tank and either gravity or pressurized disposal system as common elements. The main differences between the processes are the specific technologies employed after the septic tank and before the point of disposal. Provided that a Group 1 system is designed to accommodate possible future upgrades, doing so would be straightforward. Existing Group 1 systems are another matter altogether. Although there are few technical limitations in doing so, each specific situation would require an evaluation of the available space, and topography. For older residential systems especially, space limitations often make upgrading septic systems impractical.

Status Under Montana Regulations

The septic tank and gravity soil absorption system is very common in Gallatin County. Both State and Gallatin County regulations allow this system for homes having up to three bedrooms and don't have special site restrictions. Current Gallatin County regulations require pressure distribution systems for homes with more than three bedrooms. Section 16.1 of the Gallatin County Health Code-Chapter 3 gives EHS the option to require pressure distribution in areas where soils or other site conditions are marginal. The Gallatin County regulations also require pressure distribution if local soil conditions require it. Site specific conditions such as seasonally high groundwater levels or poor soils can prevent the use of an "approved" system or any system at all.

Range of Loads Efficiently & Economically Served

Because of their limited treatment capabilities, and existing county regulations, the use of Group 1 systems with gravity drain fields is limited to three bedroom residences having an expected flow of about 230 gallons/day. Group 1 systems with pressure absorption drain fields can be used for residences with more than three bedrooms provided that site conditions such as soils character, seasonally high groundwater, or background nitrate concentration do not create a need for additional technologies.

Land Area Required

Group 1 systems require land for the septic tank, the drain field, plus additional land for a spare drain field. Although the required land area will vary on specific site conditions, a generalized land requirement can be determined using an average soil hydraulic capacity of 0.75 gallons per square foot per day across the county. Using this absorption rate and standard absorption trench design guidelines, approximately 1200 square feet of suitable land will support the drain field requirements for a three bedroom home with average flow of 230 gallons per day. As the relationship between drain field size and flow rate is linear, a unit factor of 5.2 square feet per gallon of capacity can be used to estimate land requirements for larger systems.

Treatment of Commercial & Industrial Flows

Montana DEQ regulations do not allow any non-domestic strength wastewater be discharged into any Group 1 system.

2.2 Group 2 Systems

Overview

Group 2 systems are similar to Group 1 systems but also include a secondary treatment process that provides higher treatment levels. Examples of Group 2 systems are also shown in Figure 3C-1. In general, the secondary treatment process consists of an engineered media bed filter designed to support bacterial growth. These bacteria provide much higher levels or organic and nitrogen removals than compared to the Group 1 systems. Group 2 systems are usually implemented in cases where regulatory agencies have prescribed higher treatment levels for a specific project location. An example would be where local groundwater modeling identifies a maximum allowable effluent nitrate concentration.

Septic Tank Process Description

The septic tank process description is provided under the Group 1 systems discussion above and is not repeated here.

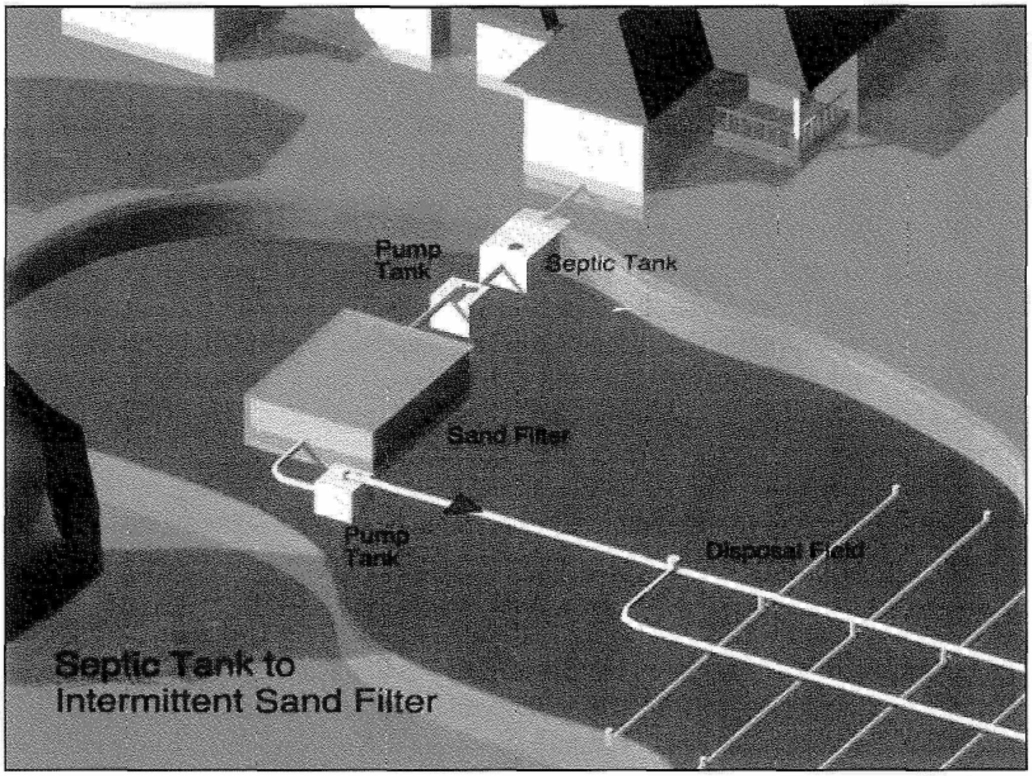
Absorption System Process Description

The absorption system process description is provided under the Group 1 systems discussion above and is not repeated here.

Intermittent Media Filter Process Description

The intermittent media filter (IMF) is depicted in Figure 3C-4 below. As shown, the filter consists of a container filled with a specific grade of well sorted sand. Effluent is pumped across the top of the filter after which it slowly percolates downward through the media. Microbes colonize the surfaces of the sand grains functioning as a fixed film type of bioreactor. By correctly sizing the filter, aerobic conditions are maintained throughout its depth. Wastewater makes a single pass through the filter and is then collected and drained or pumped to the soil absorption system.

Figure 3C-4. Drawing of an intermittent media filter.



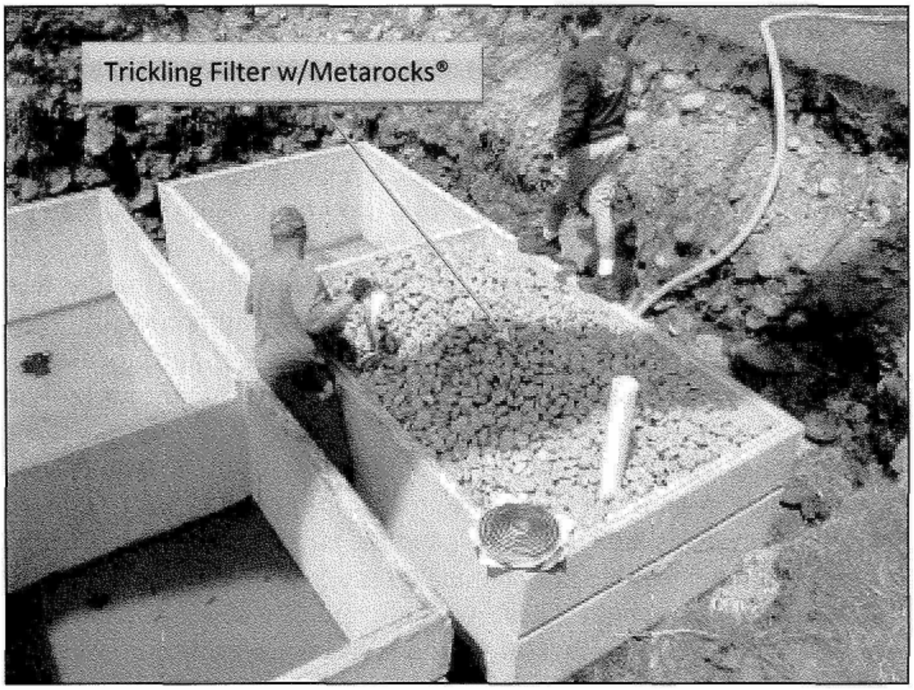
Effluent from the septic tank flows into a dosing tank and is then evenly distributed under pressure to a below-grade sand bed. Treated effluent is disposed in a traditional gravity or pressure dosed absorption system.

<u>Recirculating Media Filter Process Description</u>

Another type of secondary treatment process is the recirculating media filter (RMF). This system is similar in design to the intermittent filter described above except that the treated effluent is collected and recirculated to the filter for additional treatment. Depending on the specific treatment objectives, these systems can be designed with recycle rates of 5 times or greater. The typical recirculating media filter is a patented system that uses a proprietary media.

An example system is shown in Figure 3C-5 below. Wastewater from a dosing/recirculation tank is periodically pumped to the top of the filter media, evenly applied, and allowed to trickle through the filter media. Effluent collected at the bottom of the filter bed flows back to the dosing/recirculation tank, where some of the wastewater is then discharged to a final disposal structure, and the remainder is again passed over the filter media. This recirculation design allows the wastewater to be passed over the filter media multiple times. These filters have both anaerobic (without oxygen) and aerobic (oxygenated) zones that allow a variety of bacteria to flourish. These mixed communities of organisms do a good job of removing conventional pollutants as well as some nitrogen removal.

Figure 3C-5. Photograph of an Eliminite® recirculating media filter installation.



This system uses a patented media to provide a large surface area for bacteria growth. Wastewater trickles through the media and back to a dosing/recirculation tank. Photo courtesy of Fluidyne Inc.

Cost

For discussion and planning purposes, the capital cost of Group 2 systems is expected to range from about $20,000 to $30,000 for a typical home having 2.3 occupants and a flow rate of 230 gallons per day. The costs are obviously much higher because primary, secondary, as well as a disposal system are all required. Additionally, the media filters typically use pumps for distribution and/or recycle further adding to costs. Cost figures are total costs and include site evaluations, engineering and permitting as well as system installation. The installed cost of these systems expressed in terms of dollars per gallon of treatment capacity ranges from $87 per gallon of capacity to $130/gallon of capacity.

The true economic cost was also determined for these systems. The true economic cost takes the capital, operation and maintenance, and land costs and spreads them over a 20 year time frame with an assumed interest rate of seven percent. Twenty years was selected based on the assumption that a "typical" system lasts about 20 years. Based on this analysis, the true economic cost for Group 2 systems ranges from about $3300 to $4700 per year per connection. As previously discussed, replacement drainfield costs are not included (see Appendix S).

Comparative Degree of Treatment Obtained

Group 2 systems can provide significantly better treatment levels than Group 1. Intermittent media filters can achieve BOD removal rates of 90% or better and total nitrogen remove rates of 18 to 33% (EPA/625/R-00/008-TFS56). The corresponding effluent concentrations are 10 mg/L BOD, and 40 mg/l total nitrogen. Recirculating media filters provide additional removal of nitrogen; they have been shown to remove at least 60% of the total nitrogen producing with effluent total nitrogen concentration of 24 mg/1 or less.

Table 3C-2 Group 2 Treatment Systems Expected Septic Tank Effluent Composition	
Parameter	**Value**
Biochemical oxygen demand	10 Mg/l or less
Total Suspended Solids, Oil & Grease	25 Mg/l or less
Total Nitrogen	40 Mg/l IMF; 24 Mg/l RMF
Pharmaceutical Compounds	No Removal

The Gallatin Local Water Quality District (GCWQD) reviewed DEQ monitoring data for 8 ISF systems in Gallatin County that serve individual structures. Seven effluent sampling results were available for the 8 systems in the County. The average effluent total-nitrogen concentration was 33.7, which is well within the approved rating of 40 mg/l for these systems. However, the range of total-nitrogen effluent concentrations was 3.4 to 117 mg/1. One sample, at 117 mg/1 was above the 40 mg/l standard.

Data for RMF's serving various commercial sources was also reviewed by the GLWQD. Three of five commercial systems showed effluent total nitrogen concentrations at or below the rated capacity of 24 mg/l. The other two systems exceeded this limit. The 22 influent samples averaged 63.4 mg/1 total nitrogen with a range of between 16 and 124 mg/1. Monitoring results for 20 effluent samples showed an average effluent concentration of 29.4 mg/1, above the standard, and had a range of 4.7 to 60.8 mg/1.

GLWQD again reviewed DEQ records for 15 RMF's serving individual sources in Gallatin County. The average of 27 effluent total nitrogen samples 26.9 mg/1 and is slightly higher than the 24 mg/1 standard. The samples ranged from 4.9 mg/1 to 99.8 mg/1 with 44 percent of samples exceeding the standard.

Ease of Upgrade to Higher Levels

Some Group 2 systems can be upgraded to a Group 3 system that provides additional nitrogen removal capability. An upgrade of this type would likely include an additional media bed and possibly a supplemental carbon source (methanol addition) to support higher levels of nitrogen removal (denitrification).

Status Under Montana Regulations

DEQ maintains an updated list of approved nitrogen-reducing treatment systems including IMF's and RMF's. This list, along with other information on nitrogen reducing systems is available on the DEQ's web site. The IMF is approved by Montana DEQ for non-public applications requiring an effluent concentration of 40 mg/l total nitrogen. The RMF is approved for non-public applications at 24 mg/l total effluent nitrogen. In other words, assumed total nitrogen concentrations of 40 and 24 mg/l may be used in site specific modeling studies evaluating the use of these technologies. Please note that an "approved" system still requires that site conditions such as soil type and depth to the seasonally high groundwater level meet state standards and that deployment of an "approved" system is not guaranteed.

The DEQ approval list does change from time to time and that distinctions are made as to which systems are suitable for decentralized (non-public) and centralized (public) use. At the present time, only two specific brands of systems are approved for decentralized use. The other systems are approved for use as public sewage systems and will be addressed in later sections of this report.

<u>Range of Loads Efficiently & Economically Served</u>
Decentralized applications of Group 2 systems are limited by Montana regulations to 25 persons or 15 connections whichever is less. Considering the maximum allowable condition, the largest systems would have flows of about 2500 gallons per day.

<u>Land Area Required</u>
Group 2 systems require land for the septic tank, the filter unit plus any supporting equipment, the drain field, plus additional land for a spare drain field. Although the required land area will vary on specific site conditions, a generalized land requirement can be determined using an average soil hydraulic capacity of 0.75 gallons per square foot per day across the county. Using this absorption rate and standard absorption trench design guidelines, approximately 1200 square feet of suitable land will support the drain field requirements for a three bedroom home with average flow of 230 gallons per day. As the relationship between drain field size and flow rate is linear, a unit factor of 5.5 square feet per gallon of capacity can be used to estimate land requirements for larger systems.

<u>Treatment of Commercial & Industrial Flows</u>
Montana DEQ regulations do not allow any non-domestic strength wastewater or toxicants be discharged into any Group 2 system. For this reason, pretreatment of any commercial or industrial component would be the preferred method of management.

2.3 Group 3 Systems

<u>Overview</u>
Group 3 systems are similar to Group 2 systems but utilize tertiary treatment process to provide additional removal of nitrate. (Many of the tertiary processes available are not approved for use in Montana.) The best example of a Group 3 treatment process is a RMF discharging to a packed bed filter. Because the RMF effluent is already highly treated, a supplemental carbon source is added to the effluent to support growth of denitrifying (nitrogen removing) bacteria. Group 3 systems could be implemented in cases where an effluent less than 24 mg/l nitrate were required.

Additional processes could be added to achieve additional treatment objectives such as micro pollutant (pharmaceutical) removal. In this instance, effluent filtration flowed by an ultraviolet light-peroxide step would be required.

Although a system like this could theoretically be constructed as a decentralized system, it's likely that the cost and operational complexity would prohibit its successful application and in fact would guarantee its failure.

<u>Septic Tank Process Description</u>
The septic tank process description is provided under the Group 1 systems discussion.

<u>Absorption System Process Description</u>
The absorption system process description is provided under the Group 1 systems discussion.

<u>Intermittent Media Filter Process Description</u>
The intermittent media filter (IMF) is described under Group 2 systems discussion.

<u>Recirculating Media Filter Process Description</u>
The recirculating media filter (RMF) is discussed under Group 2 systems.

<u>Cost</u>
For a typical home having 2.3 occupants and a flow rate of 230 gallons per day, the capital cost of Group 3 systems is expected to range from at least about $35,000 to $50,000 or more depending on

the specific treatment objective. The costs are obviously much higher because primary, secondary, and possible multiple tertiary treatment processes are all required. Cost figures are total costs and include site evaluations, engineering and permitting as well as system installation. The installed cost of these systems expressed in terms of dollars per gallon of treatment capacity ranges from $150 per gallon of capacity to $220 per gallon of capacity.
The true economic cost was also determined for these systems. The true economic cost takes the capital, operation and maintenance, and land costs and spreads them over a 20 year time frame with an assumed interest rate of seven percent. Twenty years was selected based on the assumption that a “typical” system lasts about 20 years. Based on this analysis, the true economic cost for Group 3 systems ranges from about $5400 to $7700 per year. These costs do not include the costs for replacement drainfields (see Appendix S).

Comparative Degree of Treatment Obtained
Group 3 systems are likely to provide significantly better nitrate treatment levels than other systems. Because packed bed units are not approved for use in Montana, little relevant performance data exists for these systems. Systems installed in other states can remove nitrogen well below 24 Mg/l with some installations approaching single digit values. Micro pollutant removal with the UV light + peroxide process is unapproved and undemonstrated in small decentralized systems. However, based on the authors experience with these systems in other larger applications, there is no reason (other than expense and complexity) why a small scale UVP process could not work.

Table 3C-3
Group 3 Treatment Systems
Expected Septic Tank Effluent Composition

Parameter	**Value**
Total Nitrogen	Less than 24 Mg/l expected
Pharmaceutical Compounds	Destruction possible with filtration and UV light = peroxide

Ease of Upgrade to Higher Levels
Group 3 systems represent are the most complex and expensive of the decentralized systems. The addition of more processes would likely render such systems impossible to operate. As a result, Group 3 systems are considered infeasible to upgrade.

Status Under Montana Regulations
DEQ maintains an updated list of approved nitrogen-reducing treatment systems including IMF’s and RMF’s. This list, along with other information on nitrogen reducing systems is available on the DEQ’s web site. The IMF is approved by Montana DEQ for non-public applications requiring an effluent concentration of 40 mg/l total nitrogen. The RMF is approved for non-public applications at 24 mg/l total effluent nitrogen. *The packed bed nitrogen removal system is not approved at this time.*

At the present time, Montana has no regulations for allowable micro pollutant concentrations in wastewater. Thus, there is not an approval process for UVP type systems.

Range of Loads Efficiently & Economically Served
Decentralized applications of Group 3 systems are limited by Montana regulations to 25 persons or 15 connections whichever is less. Considering the maximum allowable condition, the largest systems would have flows of about 2500 gallons per day.

As with all types of wastewater treatment systems, the cost structure of Group 3 systems improves with increasing size. A Group 3 system with tertiary packed bed nitrogen removal technology servicing the maximum allowable load (25 persons) for a non-public system has an installed cost is about $115 per gallon of capacity. Following the same cost calculation methodology, the true economic cost for this system would be around $4000 per year. These values are on the lower end of the cost ranges provided above.

Land Area Required
Group 3 systems require land for the septic tank, the filter unit plus any supporting equipment, the drain field, plus additional land for a spare drain field. Although the required land area will vary on specific site conditions, a generalized land requirement can be determined using an average soil hydraulic capacity of 0.75 gallons per square foot per day across the county. Using this absorption rate and standard absorption trench design guidelines, approximately 1200 square feet of suitable land will support the drain field requirements for a three bedroom home with average flow of 230 gallons per day. As the relationship between drain field size and flow rate is linear, a unit factor of 5.5 square feet per gallon of capacity can be used to estimate land requirements for larger systems.

Treatment of Commercial & Industrial Flows
Montana DEQ regulations do not allow any non-domestic strength wastewater or toxicants be discharged into any Group 2 system. For this reason, pretreatment of any commercial or industrial component would be the preferred method of management.

SECTION D
OVERVIEW OF CENTRALIZED WASTEWATER TREATMENT TECHNOLOGIES & ECONOMICS

1. OVERVIEW

Centralized wastewater treatment systems are public systems that provide sewage treatment and disposal services. In Montana, public wastewater systems are defined as having greater than 25 persons or 15 service connections whichever is less. Because service is provided to multiple structures over a wider geographic area, collection systems such as gravity sewers lift stations and force mains are included. Compared to decentralized facilities, centralized facilities:

- Are larger and more complicated than central systems,
- Are usually operated by state-certified operators,
- Are permitted and routinely monitored,
- Are often less expensive on a cost per user basis,
- Produce a higher quality, more consistent effluent.

2. CENTRALIZED SYSTEM REVIEW

The scope of work for this project requires that centralized facilities be classified according to several criteria including their cost, degree of treatment, ease of upgrade to higher levels, status under Montana regulations, range of loads efficiently and economically served, land area required, and where practicable the adjustments to those facilities that would allow the appropriate treatment of commercial and/or industrial wastes. Figure 3D-1 provides simplified block flow diagrams and comparative information for several types of decentralized wastewater treatment systems. Referring to this figure, the universe of available systems has been organized into 3 general groups ranging from larger versions of the Group 2 and Group 3 systems (previously discussed) to the most advanced technologies available today. A generalized discussion of each system type is provided below:

2.1 Group 4 Systems

Overview

In general Group 4 systems are larger public versions of the Group 2 systems previously discussed. Depending on their size and specific application, Montana DEQ may require additional equipment such as emergency generators or ultraviolet light disinfection.

Process Description

Group 4 systems typically include a large community septic tank, a recirculating media filter, possibly an ultraviolet light disinfection system, and a pressure soil absorption system for disposal.

With the exception of the UV disinfection system, all technologies have been discusses in the previous chapter and is not repeated here.

Disinfection is necessary for the inactivation or destruction of pathogens to prevent the spread of waterborne diseases to downstream users and the environment. Disinfection is always required for wastewater systems discharging to surface waters and can also be required for systems that discharge to groundwater. An ultraviolet light disinfection system (UV system) uses energy from a high intensity mercury arc lamp to disrupt or damage the genetic material of wastewater pathogens. This effect reduces or eliminates the organism's ability to reproduce.

Figure 3D-1
Centralized Wastewater Treatment System Examples
Total Flows Greater Than 2500 Gallons/Day

Category	Primary Treatment	Secondary Treatment	Tertiary Treatment	Disposal Method	Example System	Approximate Capacity Gal/Day	Approximate Initial Cost $/Gal of Capacity Plant/Sewers/Total	True Economic Cost $/Connection-Year Sewers Incl.	Expected Effluent Quality Mg/L of Total N	Pharmaceutical Compound Destruction ?	Relative Operational Complexity	Residuals (Sludge) Production ?	Appendix References
Group 4 Systems	Community Septic Tank	Recirculating Media Filter	UV Light Disenfection	Pressure Soil Absorption System	Bridger Pines (No UV System)	15,000	$60/$18/$78	$2,100	< 24	No	Low	From Septic Tank Pumpout, Media Cleaning	C-M
Group 5 Systems	Headworks	Sequencing Batch Reactor	Disenfection (Chlorine or UV Light)	Absorption System or Infiltration Basin	RAE	80,000	$26/$11/$37	$784	15 to 24	No	Medium	From Septic Tank Pumpout, Bioprocess	M-R
	Headworks	Sequencing Batch Reactor	Disenfection (Chlorine or UV Light)	Infiltration Basin or Land Application or River Disch.	Big Sky	600,000	$35/$37/$72	$751	15 to 24	No	Medium	From Headworks, Bioprocess	M-R
Group 6 Systems	Headworks	Activated Sludge Nitrogen (N) Removal	Membrane Separation UV Light Disenfection and Peroxide	Infiltration Basin or Land Application or River Disch.	Manhattan (No Membrane) (No Peroxide)	300,000	$22/$15/$37	$950	<10	Yes with UV Light and Peroxide Sys. or Equivalent	High	From Headworks, Bioprocess	M-R
	Headworks	Activated Sludge N & Phosphorous Rem.	Membrane Separation UV Light Disenfection and Peroxide	Infiltration Basin or Land Application or River Disch.	Polson (No Peroxide) (River Discharge)	1,000,000	$29/6/34	$960	<5	Yes with UV Light and Peroxide Sys. or Equivalent	High	From Headworks, Bioprocess	M-R

Key
Approved in Montana
Not Approved for This Application

Notes
Costs for collection sewers are included in this table
Solids handling and disposal processes not shown
Polson is a Stahly Engineering planning study only
Bridger Pines in design by Stahly Engineering

Cost

Group 4 systems are defined as any system having a design flow rate greater than 2500 gallons per day. Compared to decentralized systems which are limited to 2500 gallons per day or less, Group 4 systems will have a large range of possible costs. Major cost components include treatment and disposal and a collection system to convey wastewater to the central location. Although the collection system cost adds to the overall cost of central systems, the following examples show that, in general, the per user cost of centralized systems declines with increasing flow capacity with per user costs that are less than decentralized systems. This effect is known as an "economy of scale."

The true economic cost for centralized systems can be determined in a manner similar to decentralized systems. The true economic cost calculation amortizes the collection, treatment, and disposal costs over the same 20 year time frame. This time frame was selected because in Montana the typical state-sponsored infrastructure loan uses a 20 year term. Assuming public financing allows a 3.75 percent interest rate to be used in the calculations. This rate is substantially lower than the 7 percent rate used for decentralized systems and reflects the financing advantage available to public systems. The true ecomonic cost calculation is completed by adding the collection treatment and disposal operation and maintenance costs to the debt service cost.

Using these factors, the cost of a generic Group 4 system servicing the minimum allowable load (25 persons/2500 gallons per day) for a non-public system is expected to be about $86 per gallon of capacity with a true economic cost of around $3000 per year per connection. This example does not include a collection system which would increase the values further. As shown in Figure 3D-1, a 15,000 gallon per day Group 4 system designed for the Bridger Pines County Water and Sewer District is estimated to cost $60 per gallon of capacity for treatment and disposal, $18 per gallon of capacity for collection giving a total of $78 per gallon of capacity. The true economic cost for the Bridger Pines system is about $2100 per year per connection.

Comparative Degree of Treatment Obtained

Group 4 systems offer the lowest levels of treatment within the universe of centralized treatment technologies. As mentioned earlier, these systems are nothing more than high flow versions of Group 2 and Group 3 systems. Due to their size and scale, Group 4 systems may achieve a more consistent effluent quality than their smaller counterparts resulting from the use of certified operators and effluent testing. Larger systems also tend towards more stable and continuous flows which can markedly improve the performance of any biological treatment system. A summary of the expected Group 4 effluent characteristics is provided in Table 3D-1 below.

Table 3D-1
Group 4 Treatment Systems
Expected Septic Tank Effluent Composition

Parameter	Value
Biochemical Oxygen Demand	10 Mg/l or less
Total Suspended Solids, Oil & Grease	25 Mg/l or less
Total Nitrogen	24 Mg/l or less
Process Stability	Better at higher flows

Ease of Upgrade to Higher Levels

The ease of system upgrade is influenced in part by the design flow rate of the system. In the case of a small (2500-5000 gallon per day) Group 4 systems, upgrades for additional nitrogen removal or for disinfection could, from a technical and equipment standpoint, be readily accomplished. (Current state regulations however would prevent this—see the discussion under regulatory status below) For example, a nitrogen removal upgrade could include an additional media bed along with a supplemental carbon source such as methanol addition to maintain bacterial viability in the media bed.

The upgraded system would definitely require regular inspection and maintenance to ensure that treatment goals were obtained. Depending on the specific system implemented, there is a potential for substantial increases in O&M labor costs.

As discussed in previous sections of this report, upgrading a small system to achieve micro pollutant destruction is considered infeasible because of the resulting system complexity, operational expertise required, as well as capital and operating costs. In addition, the state has no standards or approval criteria for micro pollutant removal systems.

Status Under Montana Regulations

DEQ maintains an updated list of approved nitrogen-reducing treatment systems for both non-public and public system applications. At the present time, the list identifies only three system types that are suitable for use in a Group 4 application. All are recirculating media filters with proprietary differences. These systems are approved for applications where 24 mg/l total effluent nitrogen is sufficient. Please note that an approved system still must comply with state regulations for soil and groundwater conditions before deployment. There is no guarantee that any state-approved system can, in fact, be used.

Although the DEQ approval list does change from time to time, there is currently no approved tertiary nitrogen removing system (such as the packed bed reactor discussed above) available for upgrading a Group 4 system. Although the technology exists in other states, the Montana approval process would require the collection and certification of several years of operating data from a unit installed in a similar climate and under operational conditions similar to the proposed system.

Due to the lack of approved technological options, any upgrade of a Group 4 system would probably involve its replacement by a Group 5 system for which there are several technologies approved by Montana DEQ. The downside, obviously, in doing this is that the Group 5 treatment processes are fundamentally different from the Group 4 systems requiring that the existing Group 4 system be abandoned. Given this set of circumstances, it’s fair to say that Group 4 systems cannot be economically upgraded to a higher level of treatment.

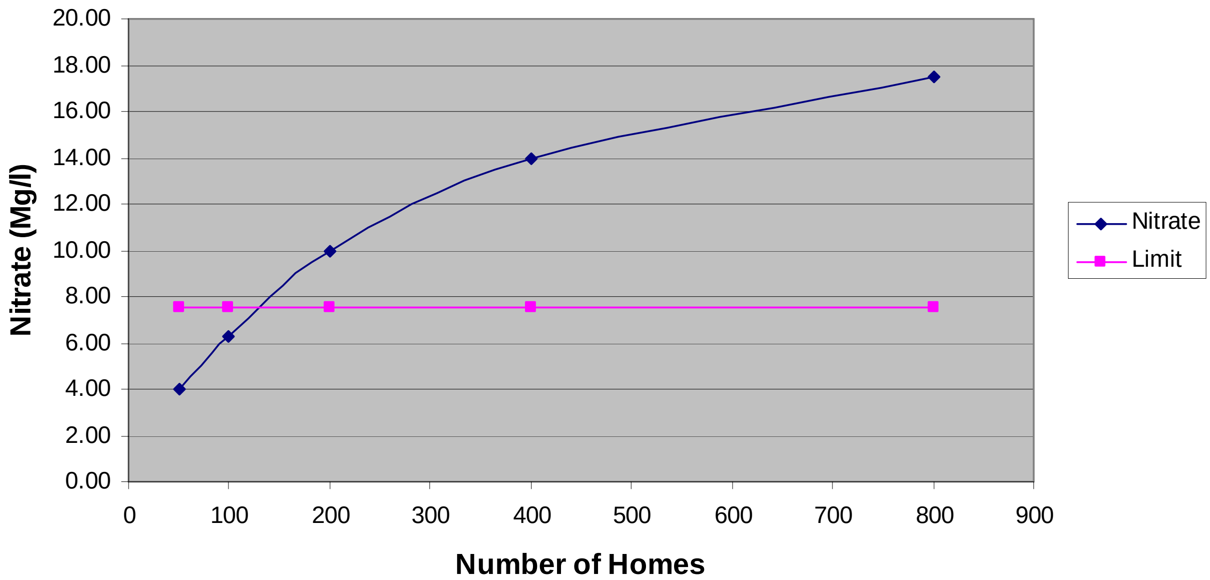
Range of Loads Efficiently & Economically Served

In previous sections it was established that Group 4 systems can serve flows greater than 2500 gallons per day where an effluent nitrogen concentration of 24 mg/l is acceptable. Historical data from a variety of projects and systems also suggests that per user costs decline with increasing flows. Although these relationships are true, the “expandability” of Group 4 systems does indeed diminish at some point. The primary constraints on the expansion of these systems include water quality limitations and absorption drain field size.

For example, we plotted the mixing zone nitrate concentration for a hypothetical drain field located “somewhere” in Gallatin County. Using common soil and hydro geologic parameters a typical drain field design, and a nitrate concentration of 24 mg/l, we generated estimates for nitrate at the end of a 500 foot mixing zone--the maximum allowed by law. These concentrations along with the water quality standard of 7.5 mg/l are plotted versus the number of homes in Figure 3D-2 below.

As shown, the water quality standards are exceeded when approximately 125 homes are connected to the system; the corresponding wastewater flow rate is about 33,000 gallons per day. Although every site is different and some specific locations may successfully achieve compliance with higher flows, the exponential shape of the curve means that large projects with flows above the 30,000 to 50,000 gallon per day range will most likely require higher levels of treatment than Group 4 systems can provide.

Figure 3D-2
Hypothetical Mixing Zone Nitrate Concentration
versus
Number of Homes on System



Land Area Required
Group 4 systems require land for the septic tank, the RMF unit plus any supporting equipment, the drain field, plus additional land for a spare drain field. Although the required land area will vary on specific site conditions, a generalized land requirement can be determined using an average soil hydraulic capacity of 0.75 gallons per square foot per day. Using this absorption rate and standard absorption trench design guidelines, a unit factor of 5.5 square feet per gallon of capacity can be used to estimate land requirements for larger systems. Please note that poor soil conditions or other site specific limitations can drastically increase the amount of land required.

Treatment of Commercial & Industrial Flows
Montana DEQ regulations do not allow any non-domestic strength wastewater or toxicants be discharged into any Group 4 system. For this reason, pretreatment of any commercial or industrial component would be the preferred method of management.

2.1 Group 5 and Group 6 Systems

Overview
The level of treatment technology and the required operational sophistication increases dramatically with Group 5 and 6 systems. These are mechanical type treatment plants containing a variety of specialized equipment and processes. Depending on the plant capacity, safety factors such as emergency generators and redundant processes and equipment may be included. These facilities also continuously produce biosolids as a byproduct; this material must be processed and properly disposed of. Larger user bases are necessary to support the both the capital and operation costs of these facilities. When correctly applied to the right set of circumstances, these systems produce a high quality effluent, including significant reductions in effluent nitrogen and phosphorous as well as a lower per user cost than Group 1, 2, 3, or 4 systems.

These systems typically utilize several unit processes including a head works, a biological treatment process, disinfection, and biosolids processing. The primary difference between Group 5 and Group 6 is the level of nitrogen and phosphorous removal; Group 6 systems provide enhanced removals of these compounds.

Head works Process Description

The primary purpose of the head works is to remove grit, trash, and debris that could clog, damage, or otherwise cause premature wear to downstream equipment and processes. A typical head works might include unit processes such as flow monitoring, screening, grit removal, and equalization.

The first step in the process is flow measuring. MDEQ requires that both the inflow and outflow from treatment be measured to within 10 percent accuracy. A flume or weir fitted with a level sensor and recorder is often used for this purpose.

The first treatment step is screening. Its purpose is to remove any refuse from the flow stream that may clog or damage the downstream processes, or that may pose a health hazard to operators. Because the screen will also remove a large quantity of organic material from the wastewater, an automatically driven washing type screen will be used. This type of unit washes the screenings and returns the organic matter back to the flow stream leaving behind mostly inert materials. These materials, known as screenings, are automatically bagged and conveyed to a dumpster with a minimum of handling. Screenings are hauled to the local landfill by a refuse hauling company.

Grit removal unit is then used to remove the heavier wastewater solids such as coffee grounds, sand, gravel, etc. Effective removal of these materials is necessary to protect the downstream process equipment from premature wear and abrasion. Additionally, early removal prevents these materials from accumulating in downstream tanks where their accumulation would be undesirable. A cyclone grit separator is a good example of a typical grit removing system; this unit spins the wastewater with a paddle wheel causing heavier material to settle out. As grit accumulates in the separator, a timer driven pump periodically transfers it to a sand screw for additional dewatering. The sand screw transfers the dewatered grit directly to a drop box for landfill disposal.

Equalization basins are used to smooth out fluctuations in the incoming wastewater flow. Wastewaters that are expected to have high variability are often equalized to improve the performance of downstream processes. Equalizing the flow can result in significant savings in the size and cost of downstream aeration equipment because peak loadings significantly decrease.

Biological Treatment Process Description

Biological or secondary treatment is the second stage in wastewater treatment systems. Here, various tankage and environmental conditions are established to promote bacterial growth. Depending on the particular treatment objective, the bacterial processes can be configured to remove organic matter, nitrogen compounds, and also phosphorous. Conventional versions of these processes can remove up to 95 percent of organic matter and, depending on how they are operated, some nitrogen and phosphorous.

Common physical configurations include "attached growth" processes and "suspended growth" processes. Attached growth processes provide a material on which microorganisms attach to form a biofilm. The biowheel process used by Manhattan Montana is a good example of a fixed film process. Suspended growth processes utilize mixing and/or aeration to promote suspended growth bacteria. The associated tank conditions may range from aerated (high dissolved oxygen level) to anoxic (low to no dissolved oxygen levels) to anaerobic (devoid of dissolved oxygen.) Each particular environmental condition favors the growth of particular bacteria which in turn results in a specific treatment objective.

Major components include the bioprocess tanks that contain the various bacteria, clarification devices such as gravity clarifiers and membrane separators which separate and return bacteria from the finished effluent, and a variety of pumps, piping, and appurtances.

Advanced versions of these processes, known as biological nutrient removal (BNR), can achieve significant nutrient reductions of nitrogen, phosphorus, or both. Most of the BNR processes involve modifications of suspended growth treatment systems so that the bacteria in these systems also convert nitrate nitrogen to inert nitrogen gas and trap phosphorus in the solids that are removed from the effluent In general, BNR processes are incorporated into wastewater treatment systems to reduce effluent TN to an average level of 8 to 10 mg/L and TP to an average of 1 to 3 mg/L.

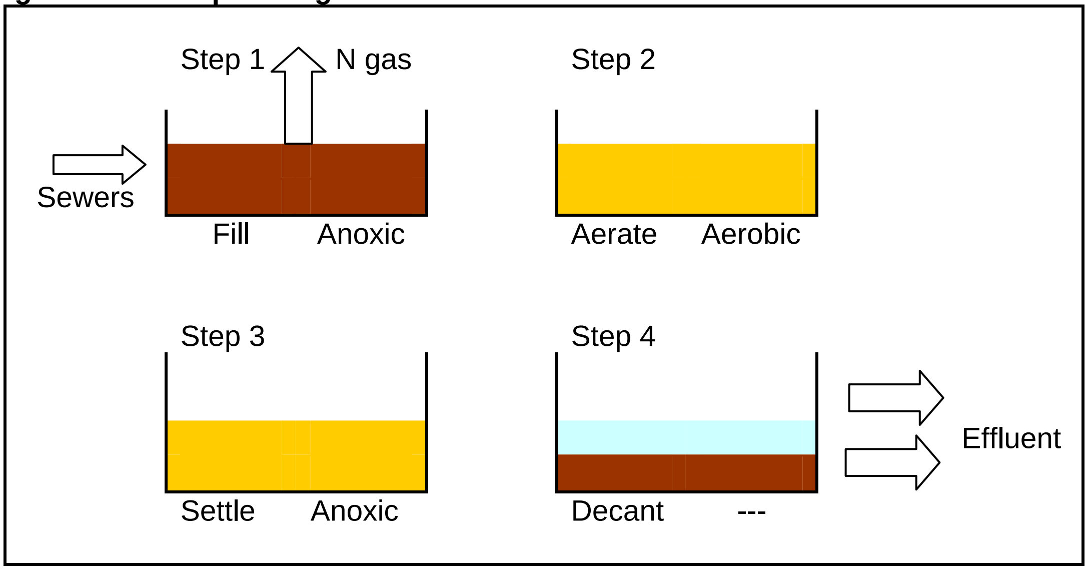
In many cases, BNR processes can be further enhanced to achieve lower levels of phosphorous (to 0.3 mg/l) and nitrogen (to 3 mg/l) using technologies such as chemical precipitation, filtration and membrane separation. These are the Group 6 systems and they represent state-of-the-art engineering concepts. As would be expected, these systems can be much higher in complexity than even Group 5 systems.

<u>Sequencing Batch Reactor Process Description</u>
For the purposes of this discussion, the sequencing batch reactor (SBR) was selected to represent the "typical" Group 5 biological process. A process schematic is shown in Figure 3D-3 below. The SBR consists of at least 2 tanks; the cycles are timed so while one tank is filling the other is processing. At the end of each cycle, the tanks are switched. SBR's operate in a batch mode and therefore incorporate many processes into a single set of tanks. SBR's are often operated in several steps achieving the following functions:

- Fill step (equalization)
- Aeration Step (organics removal and conversion of ammonia to nitrate),
- Anoxic Step (nitrogen removal via conversion of nitrate to nitrogen gas, phosphorous uptake).
- Settling step (settling and retention of bacteria for use in future steps),
- Draw step (discharge of treated and clarified effluent, removal of biosolids)

SBR systems are used locally and include facilities for the RAE and Big Sky Water & Sewer Districts. (For the interested reader, significantly more information on SBR's can be found in Appendix N.)

Figure 3D-3. Sequencing Batch Reactor Schematic



<u>Biowheel Process Description</u>

The biowheel process was selected to represent the "typical" Group 6 enhanced biological process. The Biowheel is a unique enhanced nitrogen removal process that uses both fixed film and suspended growth bacteria to achieve treatment. Designed remove about fifty percent of applied nitrogen, this process uses large, low-speed aeration cylinders to aerate and mix the treatment tanks. A separate anoxic tank is used to mix the incoming wastewater and nitrate-laden effluent resulting in the conversion of nitrate to nitrogen gas. This reaction is known as de-nitrification. The Biowheel system is used locally at the Manhattan wastewater treatment facility.

Figure 3D-4: Biowheel Installation at Manhattan Montana

Membrane Separation Process Description

In the last few years, membrane separation processes have become the method of choice for high performance solids separation applications in wastewater treatment. First developed for heavy duty industrial separation applications in the food industry, this technology is ideally suited to the exacting specifications required for enhanced biological nutrient removal systems. The enhanced nutrient removal facility now under construction for Bozeman Montana employs membrane separation technology. Other facilities are currently in the planning phase including Polson Montana and several privately owned installations.

This technology replaces conventional gravity clarifiers in the biological treatment process. In this application, hollow fiber ultra filtration membranes are placed into the process tank containing the biomass suspension. Suction applied to the membrane pulls clarified effluent through the filter leaving the biosolids in the tank. In the case where chemical precipitation is used for phosphorous removal, these precipitates are also retained. In general this process achieves a very high treatment level for pollutants of concern, reduced space requirements, and precise process control. A photograph of a typical membrane rack is shown in Figure 3D-5 below.

Figure 3D-5: Membrane Rack Prior to Submergence

Biosolids Processing Process Description

In both Group 5 and 6 systems, excess microorganisms (biosolids) are wasted from the biological process on a more or less daily basis to achieve various operational goals. As the quantity of biosolids can be large, effective processing is necessary to reduce their volume and weight prior to disposal. Biosolids processing systems include a digestion step to reduce the weight and volume of solids and a dewatering step to dry the digested solids. An additional requirement of the digestion process is to inactivate sludge pathogens and make the material safe for disposal.

Biosolids can be digested either aerobically (with oxygen) or anerobically (without oxygen) depending on specific goals and objectives. These processes are contained in large tanks which employ a variety of equipment and operational techniques. Following digestion, the sludge can is dewatered in a filtration device and then hauled to a landfill for disposal. Biosolids can also be land applied or turned into compost depending on community goals, objectives, and project-specific economics. In the case of land application, extensive dewatering is not required because a liquid state is necessary for land application. Locally, the City of Bozeman land applies their digested biosolids while Livingston and Big Sky run composting operations. The Town of Manhattan dewaters and disposes of biosolids in the Logan landfill.

Cost

Group 5 systems, with SBR used as the core biological treatment technology, are widely used for flow rates below 2 million gallons per day. Compared to decentralized systems which are limited to 2500 gallons per day or less, Group 5 systems will have a large range of possible costs. Major cost components include treatment and disposal as well as a collection system to convey wastewater to the central location.

The true economic cost for example Group 5 systems was determined as in previous examples. As shown in Figure 3D-1, true economic cost estimates for systems serving both the RAE Water & Sewer District and the Big Sky County Water & Sewer District are presented. Because these systems were constructed several years ago, it was necessary to generate construction cost estimates in today's dollars. Historical treatment plant construction costs were updated to today's dollars using the

Engineering News Record construction cost index. The collection system cost spreadsheet (See Section C.1 of this report) was used to estimate what a new collection system for each community might cost in today's dollars.

As shown, the Group 5 system serving the RAE WSD is estimated to cost about $26 per gallon of capacity for treatment and disposal, $11 per gallon of capacity for collection giving a total of $37 per gallon of capacity. Using previously presented methods, the true economic cost for this system, if it were built today, would be about $780 per year per connection. The Group 5 system serving the Big Sky County WSD is estimated to cost about $35 per gallon of capacity for treatment and disposal, $37 per gallon of capacity for collection giving a total of $72 per gallon of capacity. Using previously presented methods, the true economic cost for this system, if it were built today, would be about $751 per year per connection.

As shown, the Group 6 system serving Manhattan is estimated to cost about $22 per gallon of capacity for treatment and disposal, $15 per gallon of capacity for collection giving a total of $37 per gallon of capacity. Using previously presented methods, the true economic cost for this system, if it were built today, would be about $950 per year per connection. The Group 6 system for Polson (project not constructed) is estimated to cost about $29 per gallon of capacity for treatment and disposal, $6 per gallon of capacity for collection giving a total of $35 per gallon of capacity if constructed today. Using previously presented methods, the true economic cost for this system, if it were built today, would be about $960 per year per connection.

<u>Comparative Degree of Treatment Obtained</u>

Group 5 systems offer high levels of treatment. This is result of several factors including more continuous flows, the use of certified operators, and regular system maintenance. A summary of the expected Group 5 effluent characteristics is provided in Table 3D-2 below:

Table 3D-2
Group 5 Treatment Systems
Expected Effluent Composition

Parameter	Value
Biochemical Oxygen Demand	10 Mg/l or less
Total Suspended Solids, Oil & Grease	10 Mg/l or less
Total Nitrogen	5 to 10 Mg/l (Depends on operational strategy and specific process)
Total Phosphorous	1 to 3 Mg/l (Depends on operational strategy and specific process)

Group 6 systems offer enhanced levels of nitrogen and phosphorous removal. A summary of the expected Group 5 effluent characteristics is provided in Table 3D-3 below:

Table 3D-3
Group 6 Treatment Systems
Expected Effluent Composition

Parameter	Value
Biochemical Oxygen Demand	10 Mg/l or less
Total Suspended Solids, Oil & Grease	10 Mg/l or less
Total Nitrogen	Less than 5 Mg/l (Depends on operational strategy and specific process)
Total Phosphorous	Less than 1 Mg/l (Depends on operational strategy and specific process)

Ease of Upgrade to Higher Levels

Due to their size, cost and complexity, Group 5 and 6 systems are typically carefully planned with much consideration given to possible future changes in effluent limits. For these reasons, upgrades are typically performed to increase capacity and not necessarily in response to different effluent limits. If properly designed in the first place, these facilities will set aside land for future tanks and process equipment and will install critical items such as piping stubs and valves necessary for easy connections to future processes. Without these contingencies in place, upgrades can be extremely time consuming and expensive.

A good planning example is the Group 6 plant designed for Manhattan, Montana. Space was reserved for future tankage and process equipment that could not only double the plant's capacity but that could also provide for future enhanced nitrogen and phosphorous removal. In addition, underground piping and electrical gear was installed in areas where future excavation would be difficult or impossible.

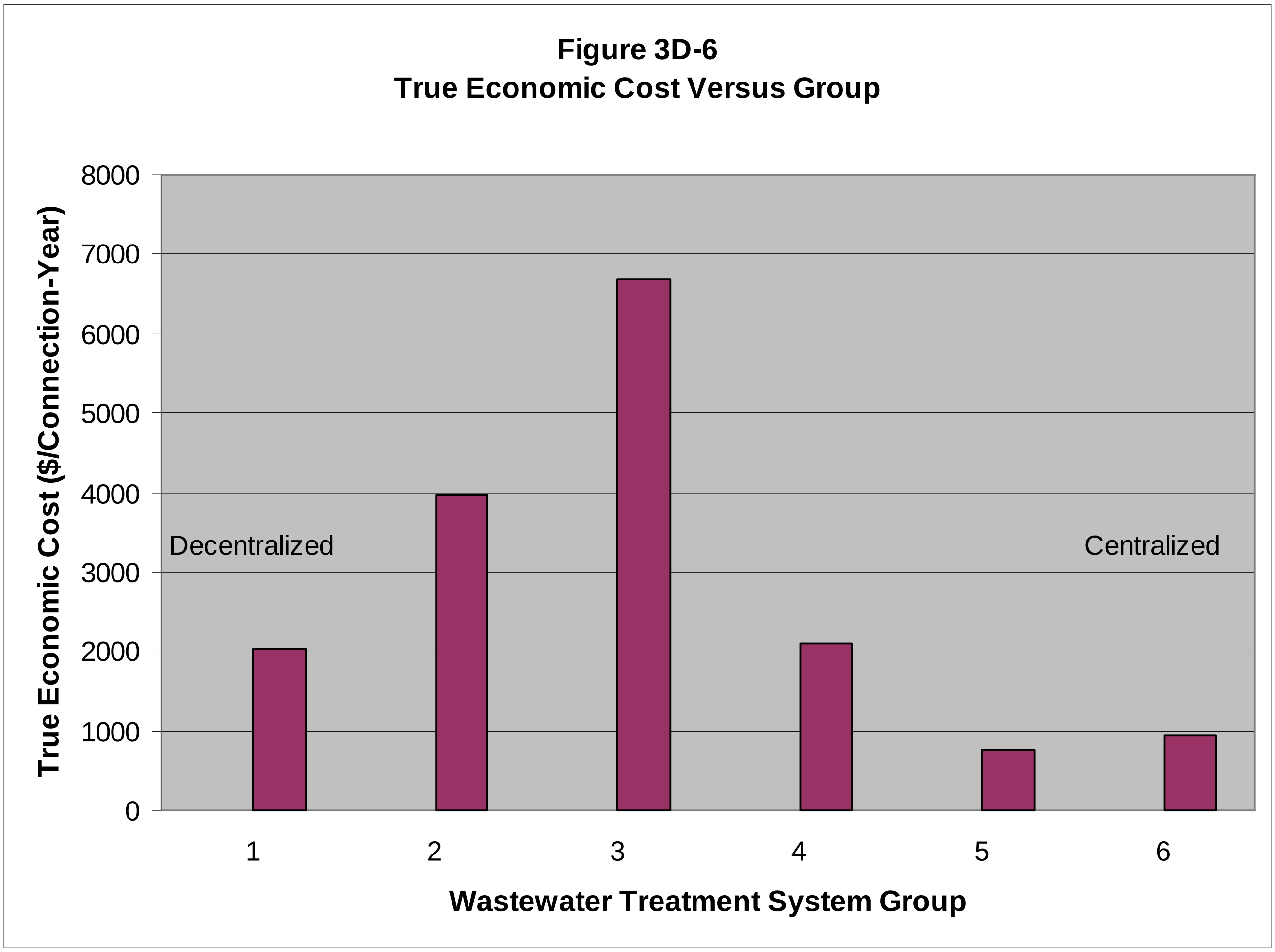
Status Under Montana Regulations

Group 5 and 6 systems using a variety of biological processes have been approved in several Montana communities. However, because of the complexity and numerous choices involved, the technology selection and approval process is more of a negotiated process than simply choosing a process from DEQ's approved technology list. The initial step usually includes the preparation of a facility plan or preliminary engineering report defining basic criteria such as the planning area and population growth characteristics, wastewater flows and loads, effluent treatment goals, and technological approach. Once the community and state agree on these factors, a design report is typically prepared outlining the exact technical project approach. With the design report completed and approved, construction plans and specifications are then prepared. These too must be approved by the agency.

Range of Loads Efficiently & Economically Served

Locally, Group 5 and 6 systems are used for flows ranging from 80,000 (RAE) to 600,000 gallons per day (Big Sky) The Manhattan facility has a capacity of 300,000 gallons per day but is successfully operating at 100,000 gallons per day. In Manhattan's case, the design capacity reflects a high rate of short term population growth that has not materialized.

Figure 3D-6 presents the average true economic cost (TEC) of all system types. As shown, the decentralized technologies (Groups 1, 2, and 3) have higher TEC's than centralized systems. What makes this comparison interesting is that the Group 4 to 6 TEC's includes the cost of the collection system. These data suggest that given the right circumstances, centralized treatment methods can efficiently and economically serve a wide range of flows.



Land Area Required

Centralized treatment facilities require land for buildings and process tankage. Adding to the land requirement are the buffer zones for maintenance equipment such as cranes, utility corridors, and truck traffic. Depending on the method of discharge significant quantities of additional land may be required. For example, based on the Manhattan central treatment facility, about 4 acres per million gallons of capacity is required for a plant with a river discharge. In the event a groundwater disposal system was used an additional 75 acres would be required based on the previously developed factor of 5.5 square feet per gallon of capacity.

Treatment of Commercial & Industrial Flows

Montana DEQ regulations do not allow any non-domestic strength wastewater or toxicants be discharged into any Group 4 system. For this reason, pretreatment of any commercial or industrial component would be the preferred method of management.

SECTION E
SPREADSHEET TOOLS

1. COLLECTION SYSTEM SPREADSHEET

A spreadsheet tool was developed to facilitate the analysis of multiple collection system cost analysis scenarios. Figure 3E-1 is an example output from the collection system tool. Input variables are shown inside the light yellow boxes located near the top of the spreadsheet and include the following variables:

- Price per linear foot for 8-inch through 48-inch gravity collection sewers,
- The quantity of residential level (8, 10, and 12-inch) sewers expressed on a linear foot per acre basis.
- The total available un-sewered acreage within each sub-region.

The spreadsheet user can vary these inputs as desired to explore a variety of alternative unit cost and parcel size alternatives. The example shown calculates both cost and linear footage of sewer systems for a hypothetical sub-region. Outputs are provided for a 20 year growth scenario (light brown), and a full build out scenario (light orange). No time frame was assigned to the full build out scenario; the date of full build out is too far in the future for any meaningful prediction. A third set of data (dark orange) is also provided. It is a composite estimate consisting of the infrastructure required for the 20 year population plus additional piping and sewer main upsizing to reflect capacity for regionalized flows. (It should be clear from the constraints analysis that areas northwest of Belgrade offer some the best possibilities for locating a regional facility.)

The spreadsheet uses population values that are based on an examination of planning and zoning requirements in force within each sub-region at the time of this study. As agreed with the water and wastewater subcommittee of the county planning board, the annual rate of population increase was assumed to be 3 percent; additional population was spatially distributed according to the zoning. For further information on population projections, please see Section 3A of this report.

Residential sewers are defined as all 8-inch, 10-inch, and 12-inch sewers necessary to service a “typical” subdivision or other development. The quantities shown in the input box were estimated from a typical 320 acre residential development using a layout generally meeting county requirements for open space, road, lot size, and other requirements. A schematic of this calculation is shown in Figure 3E-2. It should be stressed that this method is a simplistic, but useful, way to estimate subdivision or neighborhood level sewer construction costs. Planners may, of course, use other numbers at their discretion.

Unit costs for sewers were based on the 2007 Bozeman Wastewater Facilities Plan. These costs are fully burdened to account for contractor, engineering, and administrative overheads. The City of Bozeman unit cost numbers reflect the cost of working within an existing city and may overestimate the costs for sewers in newly developed areas with minimal construction interference. As with other factors, the planning department may use different numbers as they deem appropriate.

Figure 3E-1
Gallatin Regional WW Study Phase 2
ExampleCollection System Spreadsheet

Input Data

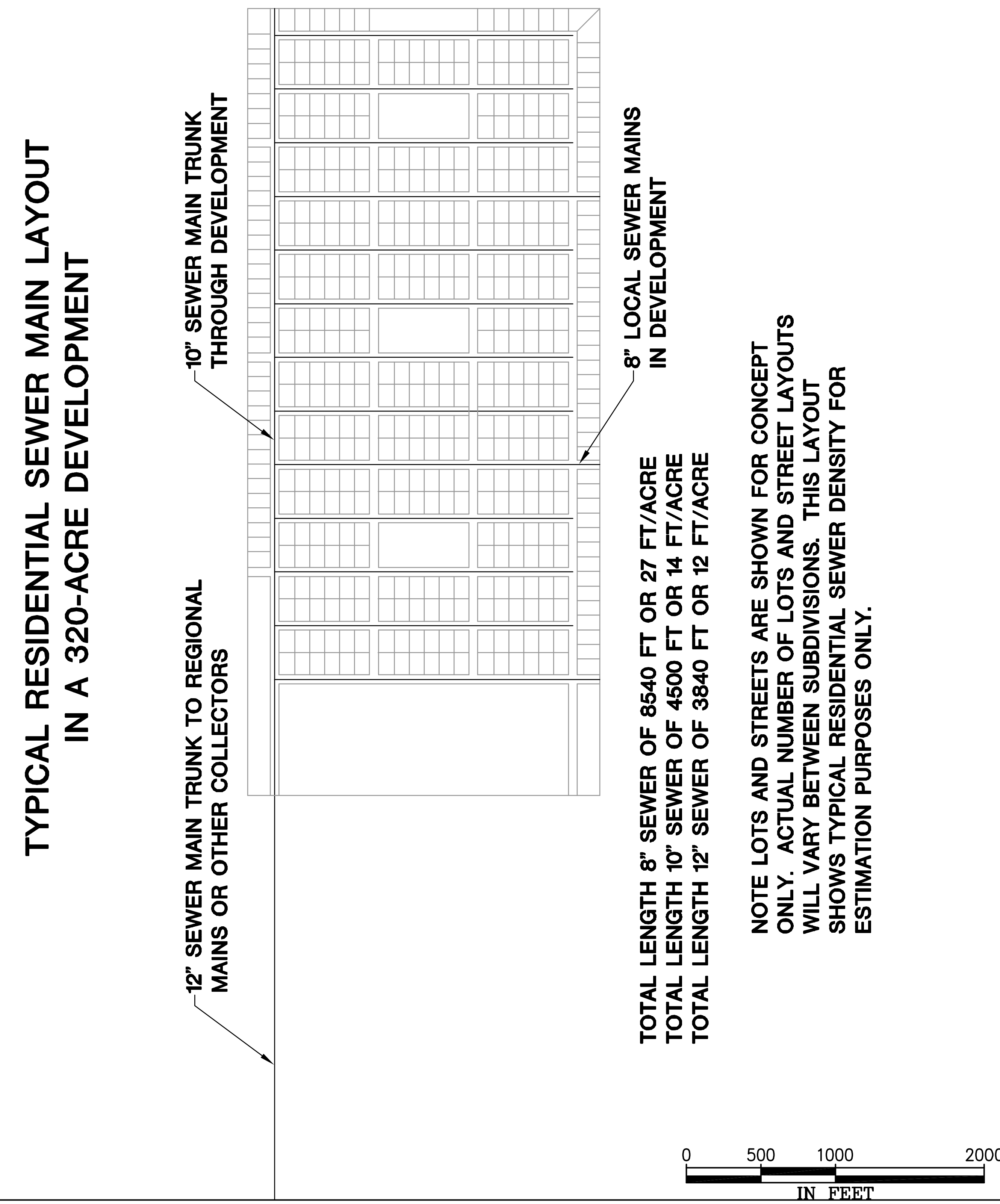
		Input Cost/FT		
Installed Sewer Cost	8" Main	$160	24" Main	$240
	10" Main	$170	30" Main	$280
	12" Main	$180	36" Main	$310
	15" Main	$200	48" Main	$380
	18" Main	$210		
	21" Main	$230		
Residential Sewer Algorithim		Input Quanity/Acre		
	8" Quantity	27	ft/acre	
	10" Quantity	14	ft/acre	
	12" Quantity	12	ft/acre	

Quantity & Cost Calculations

2010 Pop	5881
Buildout Pop	9950
2030 Pop	1724

Subregion	Area XYZ	Cost	Total
Un-sewered Area (acres)	1981		1981
2010 Population	5881		5881
2030 Population	1724		1724
Build-out Population	9950		9950
20-yr Sewer Mains			
Ft of 8" Main	9267	$1,482,799	
Ft of 10" Main	4805	$816,913	
Ft of 12" Main	4119	$741,400	
Ft of 15" Main	20000	$4,000,000	
Ft of 18" Main	0	$0	
Ft of 21" Main	0	$0	
Ft of 24" Main	0	$0	
Ft of 30" Main	0	$0	
Ft of 36" Main	0	$0	
Ft of 48" Main	0	$0	
Subtotals	38192	$7,041,112	
Build-out Subregion Mains			
Ft of 8" Main	53487	$8,557,920	
Ft of 10" Main	27734	$4,714,780	
Ft of 12" Main	23772	$4,278,960	
Ft of 15" Main	24000	$4,800,000	
Ft of 18" Main	12000	$2,520,000	
Ft of 21" Main	8000	$1,840,000	
Ft of 24" Main		$0	
Ft of 30" Main		$0	
Ft of 36" Main		$0	
Ft of 48" Main		$0	
Subtotals	148993	$26,711,660	
Build-out Regional Main			
Ft of 8" Main	53487	$8,557,920	
Ft of 10" Main	27734	$4,714,780	
Ft of 12" Main	23772	$4,278,960	
Ft of 15" Main	0	$0	
Ft of 18" Main	0	$0	
Ft of 21" Main	9000	$2,070,000	
Ft of 24" Main	9000	$2,160,000	
Ft of 30" Main	12000	$3,360,000	
Ft of 36" Main	2000	$620,000	
Ft of 48" Main	15000	$5,700,000	
Subtotals	151993	$31,461,660	

N:\0939-01809 GALLATIN COUNTY WW STUDY PH2\dwg\Figures\Fig -3E-2 Local Sewer Sizing.dwg, FIG-3E-2 TYPICAL SEWER LAYOUT, Plotted: Sep 15, 2010 - 2:06pm, brickert



WORKING DRAFT REPORT

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TYPICAL SEWER MAIN LAYOUT

REGIONAL WASTEWATER TREATMENT FEASIBILITY STUDY, PHASE 2
GALLATIN COUNTY, MONTANA

DESIGNED CDP
DRAWN CDP
CHECKED RMS
DATE 9/15/2010

SHEET
FIG. 3E-2

The spreadsheet calculates residential sewer quantities using an estimated of developed land. Developed land areas at any time are based on the population used. An estimate of developed land can be made by multiplying the total available acreage by the ratio of the 20 year population to the maximum population. This developed land estimate is then used to generate estimates of neighborhood sewer quantities. For example, the estimated quantity and cost of 8-inch sewer for a 20 year build out population of 1724 persons in the "XYZ" sub-region is calculated as follows:

- Quantity=1981 available acres x (1724 Persons in 20 Years/ 9950 Persons Maximum) x 27 Linear Feet/Acre=9267 Feet of 8-inch sewer.

- Cost= 9267 LF x $160.00/Foot=$1,483,000

The user of this spreadsheet must recognize that the neighborhood sewer quantities developed reflect an assumption that land is developed in direct proportion to population growth. This assumption may overstate the quantity and cost of neighborhood sewers; this would be especially true in the case of a high density development.

The total available acreage used in the neighborhood sewer calculations above reflects the gross land area within the sub-region (determined by the county GIS database) less exclusions for existing sewered land. Table 3E-1 below shows both the gross land and net land areas used for some of the more significant sub-regions. As with other variables, the planning department may want to adjust available land areas to explore a variety of cost sensitivities. By varying the quantity of land and the population figures, the user could use this tool to examine project phases with durations shorter than the 20 year values shown.

The quantities for the larger sewers were developed using hydraulic estimating techniques that are not suitable for inclusion in this spreadsheet. As a result, the quantities for these larger sewers were manually entered in the appropriate spreadsheet cells and should not be changed without consulting with Stahly Engineering.

Table 3E-1
Individual Sub-Region Sizes

Sub-region	Gross Area (Ac)	Net Area (Ac)	Currently Sewered Areas Excluded
West Belgrade	5187	4887	River Rock
Belgrade Facility Plan	8250	6266	Belgrade City Limits
Jackrabbit	2301	1981	Gallatin Heights Sub.
Valley Center	6674	6574	Valley Grove Phase 4
NW Bozeman	2392	2392	None
Four Corners	6669	5081	Elk Grove, North Star, Black Bull, Middle Creek

2. COLLECTION SYSTEM SPREADSHEET TEST CASE

The predictive capability of the collection system spreadsheet was tested using data from the Lockwood Montana Water and Sewer District collection system project. Lockwood Montana is currently in the process of installing a regional sewer collection system that will eventually convey sewage to the City of Billings secondary wastewater treatment facility. The initial phase that includes the regional trunk sewers and lift stations will be completed later this year. The second phase of the project involving mostly neighborhood sewer extensions and hookups will be constructed in 2011. This project is a good opportunity to perform a valuable cross check of the spreadsheet due to the many similarities to concepts evaluated in this report:

- A service area of about 7.5 square miles or 4800 acres which is equivalent to one of the larger Gallatin County sub-regions,
- An existing population of 4900 persons with an ultimate build out of 9100 persons,
- An overall density of from 1.0 (current) to 1.9 persons per acre at build out,
- All residential and non-residential structures are currently served by onsite systems,
- A completely new grass roots collection system is required.

The Lockwood service area and population data were input into the spreadsheet as described above to produce an estimate of sewer system construction costs. Doing this produced collection system cost estimates that were very similar to Lockwood's actual costs. Table 3E-2 below summarizes these comparisons. As shown, the spreadsheet tool produced a slightly higher estimate for the regional sewers than was encountered by Lockwood. Estimates for the neighborhood sewers were the same. On an overall basis, the spreadsheet produced a result that was within ten percent of actual costs.

Table 3E-2
Comparison of Collection System
Actual Versus Estimated Costs

Category	Lockwood Project	Spreadsheet Tool
Regional Trunk Lines	$22 Million	$26 Million
Neighborhood Sewers	$30 Million	$30 Million
Total	$52 Million	$56 Million

While this comparison suggests that the spreadsheet is capable of producing a conceptual level collection system cost estimate, the user is reminded that the spreadsheet is intended for planning purposes and not as the basis of major financial decisions. For those decisions, a more detailed engineering study including preliminary sewer plans, profiles, and routing is required.

3. COLLECTION TREATMENT & DISPOSAL SPREADSHEET

This spreadsheet planning tool was developed to facilitate the analysis of combined collection, treatment, and disposal scenarios. It uses the outputs from the collection system tool, described above, in combination with other engineering factors to produce comparative level cost scenarios for centralized collection and treatment concepts. As mentioned above, these cost estimates are conceptual in nature and are not to be used for major financial decisions. Figure 3E-3 is an example output from the collection system tool.

3.1 Input Values

As shown in the table, spreadsheet inputs are shown inside the light yellow boxes located at the top left of the spreadsheet. Each variable is more briefly discussed below.

<u>Treatment System Construction Cost</u>
This factor is used to approximate the construction cost of wastewater treatment facilities. It includes the direct construction costs as well as indirect costs such as engineering, administration, and permitting. Expressed on a dollar per gallon of capacity basis, this factor can have a wide range depending on the type of treatment contemplated. The reader is referred to Sections 3C and 3D for an overview of possible treatment system costs. For this project, a range of $22 to $28 dollars per gallon

of capacity reflecting a nitrogen and/or a nitrogen phosphorous removing Group 5 or 6 treatment plant is representative of a regional facility.

Treatment System O&M Cost

The operation and maintenance factor includes the costs necessary to operate and maintain the treatment facility. It includes burdened salary costs for operators, consumables such as electricity, chemicals, lab testing, and fuel, and other costs such as reserves, insurance, tools and equipment. For this project, a factor of five percent of the construction cost was selected. This factor was based on a review of the operating budgets for the Manhattan Montana Group 6 nitrogen removal plant.

Collection System O&M Cost

The collection system operation and maintenance cost factor is based on published nationwide average data by the US EPA. The factor, expressed as dollars per mile of sewer per year is $3600.00 and includes burdened labor, cleaning devices and services, inspections, and preventative maintenance.

Treated Effluent Disposal Rate

This factor represents the capacity of soils to accept treated wastewater for disposal. The factor is highly site specific and can have a wide range depending on specific circumstances. Lower values result in larger more expensive disposal facilities while higher values have the opposite effect. The factor used in this project is 1.0 gallons per square foot per day; this value is representative of application rates for highly treated and clarified effluents resulting from treatment in either Group 4, 5 or 6 facilities.

Disposal System Construction Cost

As specified in the scope of work, this project is primarily focused on subsurface discharge as a disposal method The disposal system construction cost factor represents the constructed cost of a large high rate shallow drain field consisting of gravel filled trenches, infiltrators, distribution piping and pumps and controls. This type of system can operate year round thus avoiding winter time operational issues with open basins that result in a need for storage ponds. For the purposes of this evaluation, a unit cost of $350,000 per acre should be used for the construction of this disposal system

Land Cost

A land cost of $10,000 per acre is assumed for this analysis. The user may elect to use other costs when evaluating specific sites where costs and availability are known.

Wastewater Production

A wastewater production rate of 100 Gallons per day per person was used in this analysis. This value is specified in Circular DEQ-2, Design Standards for Wastewater Facilities, and is often used for planning level project evaluations. Data from existing Montana communities typically ranges from 75 to 125 Gallons per person per day with the higher values representing older collection systems experiencing inflow and infiltration problems.

Residents Per Household

This factor is used to establish the average number of persons per dwelling unit. A factor of from 2.0 to 2.3 persons per household are commonly accepted values in this area.

Figure 3E-3
Gallatin County Regional WW Study Phase 2
Example Collection, Treatment, & Disposal Spreadsheet

Input Data	
Treatment System Construction Cost ($/Gal-Day of Capacity)	$28
Treatment System O&M Cost (Percent)	5
Collection System O&M Cost ($ Annum/Mile)	$3,600
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	1.00
Disposal System Construction Cost ($/Acre)	$350,000
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	100.0
Sub-Region Name	**Area XYZ**
Sub-Region Est. 20 Year Population	5,881
Sub-Region Est. Current Population	5,881
Capital Cost Calculations--Treatment & Disposal	
Connections	2,557
Wastewater Flowrate (Gal/Day)	588,100
Land Required For Treatment & Disposal Facilities	16
Central Treatment Facility Cost	$16,466,800
Disposal Facility Cost	$5,548,661
Land Cost	158,533
Subtotal Treatment & Disposal	22,173,995
Capital Cost Calculations--Collection System	
Collection System Cost	$20,400,000
Public Financing Factor (%)	100
Subtotal Publically Financed Collection	20,400,000
Right of Way Acquisition @ 2%	$408,000
Subtotal Collection	$20,808,000
Total of Possible Capital Costs	$42,981,995
Annualized Cost Estimate	
Grant Allowance	($850,000)
Debt or Loan	$42,131,995
Debt or Loan Reserve	$3,269,443
20 Year Bond or Loan 3.75%	$45,401,437
Annual Payment for Debt Service	$3,269,443
Annual Treatment System O&M	$1,108,700
Annual Collection System O&M	$82,884
Subtotal of Annual Costs	$4,461,026
Treatment & Disposal Debt Service ($/connection-year)	$666
Collection Debt Service	$613
Collection, Treatment & Disposal O&M	$466
Total	$1,745

Collection System Percent Publically Financed
This factor allows the user to adjust the percentage of the collection system that is publically financed. The purpose of the factor is to reflect the likelihood that many new subdivision sewers will be installed by developers and included in the price of building lots and/or structures. As a result these privately financed sewers can be excluded from the cost estimates. The recommended evaluation range is 100 percent (which assumes that all sewers are publically financed) to 30 percent (assumes that 70 percent of sewers are privately financed) which is a less conservative value.

Sub-region Information
The spreadsheet uses population values that are based on an examination of planning and zoning requirements in force within each sub-region at the time of this study. As agreed with the water and wastewater subcommittee of the county planning board, the annual rate of population increase was assumed to be 3 percent. For further information on population projections, please see Section 3A of this report.

The spreadsheet user can vary these inputs as desired to explore a variety of collection treatment and disposal scenarios for each sub-region. It is also possible to combine sub-regions or (with assistance of the county GIS department) to define different sub-regions or study areas than the ones used in this report.

3.2 Outputs

Annualized Cost Estimate
The spreadsheet calculates an annualized cost estimate for a hypothetical collection treatment and disposal system using the specified input values. The cost estimate is computed using several assumptions as listed below:

- Treasure State Endowment Grant funding in the amount of $750,000 is available,
- Montana Renewable Resource Grant funding in the amount of $100,000 is available,
- Twenty year financing at 3.75 percent through either bonds or loans or a combination of both.

The resulting annual cost per connection is determined by dividing the annual costs for debt service, operation, and maintenance by the estimated number of connections with a total given at the bottom.

Annualized costs and unit costs are for comparative purposes only and are not to be misconstrued as utility rate estimates.

All estimates generated by these spreadsheets reflect collection, treatment, and disposal facilities given the requirements of the county scope of work and the previously described assumptions and inputs. The estimates assume that the facility is constructed as a single project in today's dollars. The implementation and cost benefits of typical large-project management techniques such as multi-year planning, sequencing, and phasing are excluded from these estimates.

PART 4

SCREENING OF ALTERNATIVES
1-6

SECTION A
INTRODUCTION & SUMMARY

1. INTRODUCTION

Part 4 conceptually evaluates collection, treatment, and disposal systems for several individual sub-regions selected from within the study area. These sub-regions, relative to the overall study area, are projected to contain the highest future densities and may represent the best opportunities to someday establish economical centralized collection, treatment, and disposal services. The sub-regions are listed below and are also shown on Figure 4A-1.

1. West Belgrade
2. Belgrade Facility Plan Area
3. Jackrabbit
4. Valley Center
5. Northwest Bozeman Community Plan
6. Four Corners

A fair amount of engineering judgment was used in defining the sub-region boundaries. Of primary importance was the zoning based growth projections. Recalling from Part 3A of this report, zoning based projections allocate future growth to areas that are zoned to accept growth. Geographical considerations such as the location of major subdivisions, population centers, as well as required study exclusions also played a role.

The definition of these sub-regions also reflected potential constraints such as site limitations for subsurface effluent disposal and water rights. In the case of disposal, considering multiple sub-regions with smaller disposal volumes may provide a more successful pathway to groundwater discharge permitting as compared to a single large disposal site.

In addition, potential water rights regulations could prevent the widespread collection and disposal of wastewater in locations which are “far” from a point of origin such as a public water supply well. According to our discussions with regulators and water rights attorneys, some of the conveyance distances contemplated in this report could create complicated issues in cases where effluent transport could conflict with mitigation measures attached to existing water rights. This problem will be more prevalent in areas where new water sources remain to be developed.

Although excluded from the study area, the Belgrade Planning Area has a large un-sewered area located outside of the existing city limits and inside the planning area. Because the scope of work allows inclusion of areas that may improve the economic practicality of central sewer service, the Belgrade Facility Planning Area was included in this study.

A summary of centralized collection and treatment costs for all of the alternatives is presented below. Starting in Section B, each alternative is individually described in more detail including a description, a population and flow summary, a repeat of the economics, and a brief discussion of the general facility requirements and considerations. Generalized recommendations for locating sewer trunk lines, treatment, and disposal facilities are also provided.

2. SUMMARY

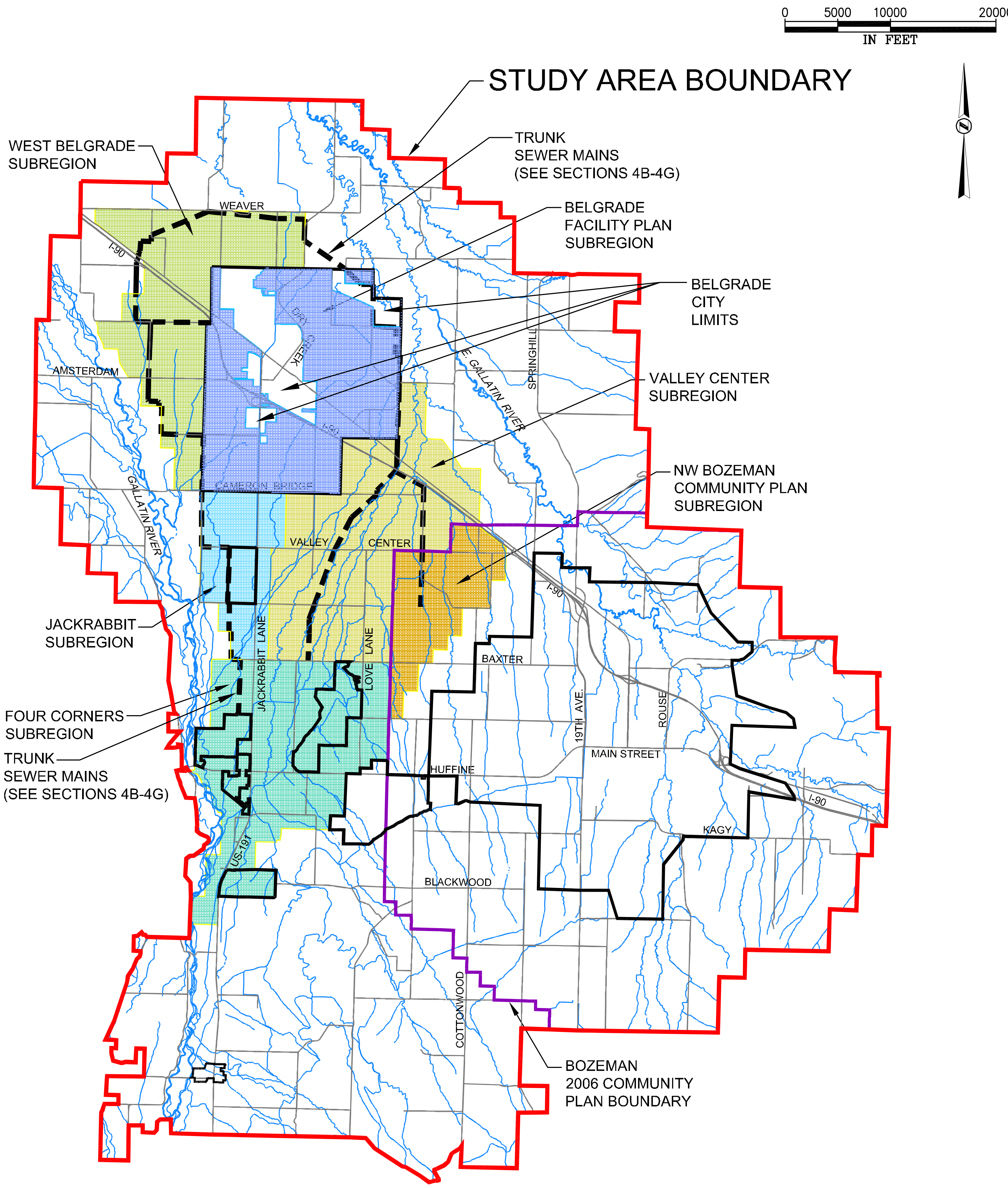
Basic Analysis
The previously presented zoning and population evaluations and cost calculation spreadsheets were used to generate estimates of collection, treatment, and disposal costs for each of the sub-regions. A

near term time horizon of 20 years was used in these computations. Table 4A-1 provides a side by side analysis of estimated collection system costs; Table 4A-2 provides combined collection treatment and disposal cost estimates for the sub-regions assuming 100 percent of sewers are publically financed and that treatment plant construction costs $28 per gallon of capacity. This value reflects the cost of a Group 6 treatment facility capable of achieving both nitrogen and phosphorous removal. For the given set of inputs, the average cost of the six alternatives is about $1530 per connection per year with a range of from $1390 to $1700 per connection per year.

Sensitivity Analysis

In Table 4A-3, we changed the collection system public financing percentage to 30 percent to provide a more realistic share of publically financed sewer infrastructure. Using a figure of 30 percent means that 70 percent of the sewer infrastructure cost is allocated to future development projects. Table 4A-3 also used a lowered treatment plant construction cost of $22 per gallon of capacity to reflect the need for nitrogen removal alone versus a combined nitrogen and phosphorous removal system. For this set of inputs, the average cost of the six alternatives is about $1020 per connection per year with a range of from $990 to $1100 per connection per year.

N:\0939-01809 GALLATIN COUNTY WW STUDY PH2\dwg\Figures\Fig -4A-1 Study Area Sub Regions.dwg, FIG-4A-1 SUB REGIONS, Plotted: Sep 15, 2010 - 2:10pm, brickert



WORKING DRAFT REPORT

FIG. 4A-1

SHEET

DESIGNED CDP
DRAWN BAR/CDP
CHECKED RMS
DATE 9/15/2010

STUDY AREA SUB REGIONS

REGIONAL WASTEWATER TREATMENT FEASIBILITY STUDY, PHASE 2 GALLATIN COUNTY, MONTANA

ISSUE

No.	DATE	DESCRIPTION	BY
1	JULY, 2010	WORKING DRAFT REPORT	BAR
2	9-17-2010	WORKING DRAFT REPORT	BAR

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Resulting Cost Ranges

The resulting cost ranges for each sub-region are presented in Figure 4A-2 below. Recalling the discussion and analysis of decentralized treatment systems from Part 3C of this report, unit costs for onsite systems (Groups 1 and 2) were estimated at $2000 to $4000 per connection per year. Comparing the costs for centralized collection and treatment to these numbers clearly shows that centralized treatment would cost significantly less than decentralized treatment over the long term.

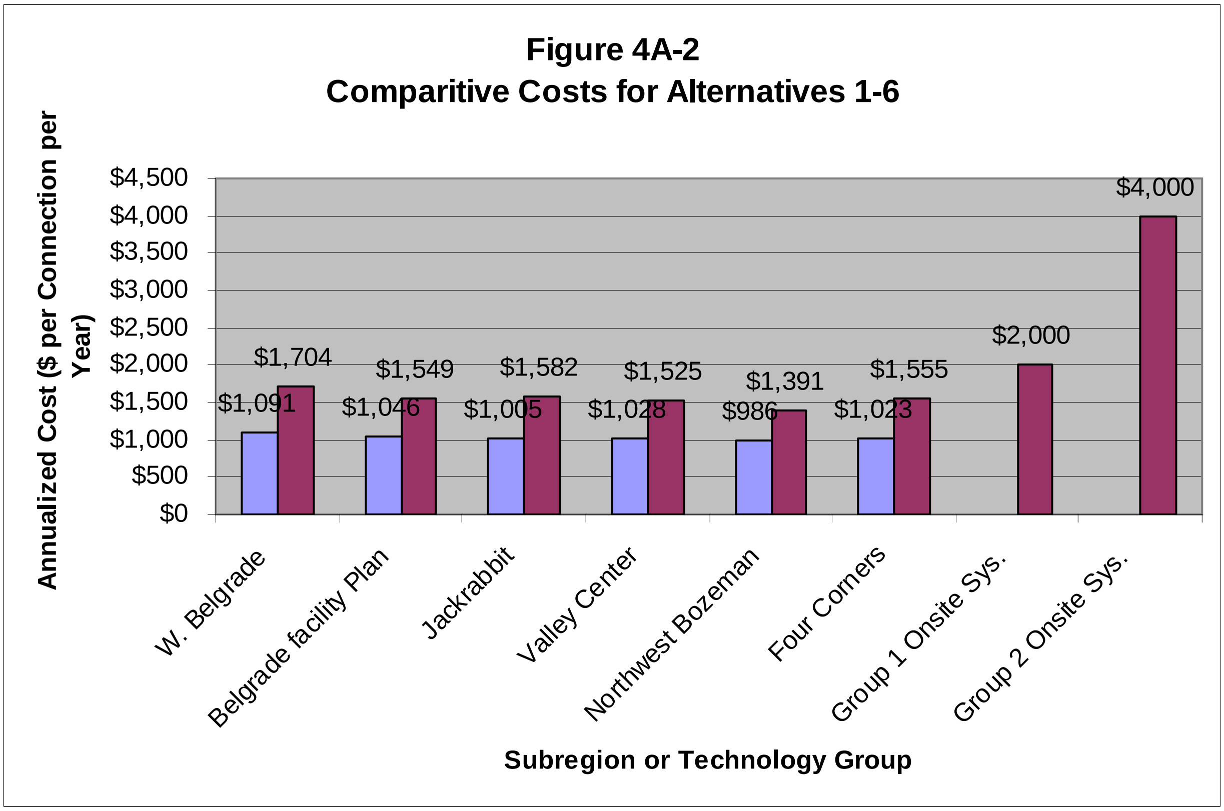


Table 4A-1
Gallatin Regional WW Study Phase 2
Collection System Spreadsheet

Input Data

Installed Sewer Cost	Input Cost/FT		
8" Main	$160	24" Main	$240
10" Main	$170	30" Main	$280
12" Main	$180	36" Main	$310
15" Main	$200	48" Main	$380
18" Main	$210		
21" Main	$230		

Residential Sewer Algorithim	Input Quanity/Acre	
8" Quantity	27	ft/acre
10" Quantity	14	ft/acre
12" Quantity	12	ft/acre

Quantity & Cost Calculations

2010 Pop	13445
Buildout Pop	115590
2030 Pop	28447

Subregion	West Belgrade	Cost	Belgrade FP	Cost	Jackrabbit	Cost	Valley Center	Cost	NW Bozeman CP	Cost	Four Corners	Cost	Total
Un-sewered Area (acres)	4887		6266		1981		6574		2392		5081		27181
2010 Population	5881		990		223		2309		350		3692		13445
2030 Population	7316		5600		1748		6130		2653		5000		28447
Build-out Population	14998		30277		9910		26585		14977		18843		115590
20-yr Sewer Mains													
Ft of 8" Main	64365	$10,298,321	31292	$5,006,674	9434	$1,509,510	40928	$6,548,431	11440	$1,830,448	36403	$5,824,423	
Ft of 10" Main	33374	$5,673,612	16225	$2,758,307	4892	$831,628	21222	$3,607,700	5932	$1,008,441	18875	$3,208,826	
Ft of 12" Main	28606	$5,149,161	13907	$2,503,337	4193	$754,755	18190	$3,274,216	5085	$915,224	16179	$2,912,211	
Ft of 15" Main	20000	$4,000,000	10000	$2,000,000	12000	$2,400,000	10000	$2,000,000	5000	$1,000,000	10000	$2,000,000	
Ft of 18" Main	0	$0	10000	$2,100,000		$0		$0		$0		$0	
Ft of 21" Main	0	$0		$0		$0		$0		$0		$0	
Ft of 24" Main	0	$0		$0		$0		$0		$0		$0	
Ft of 30" Main	0	$0		$0		$0		$0		$0		$0	
Ft of 36" Main	0	$0		$0		$0		$0		$0		$0	
Ft of 48" Main	0	$0		$0		$0		$0		$0		$0	
Subtotals	146345	$25,121,094	81424	$14,368,318	30519	$5,495,893	90340	$15,430,347	27457	$4,754,113	81457	$13,945,460	

Build-out Subregion Mains
This condition not used for individual sub-region analysis
Belgrade FP Area Populations are net of the existing population of 7700

Build-out Regional Main
This condition not used for individual sub-region analysis

Table 4A-2

Gallatin County Regional WW Study Phase 2
Collection, Treatment, & Disposal Spreadsheet
Subregions Considered Separately

Input Data						
Treatment System Construction Cost ($/Gal-Day of Capacity)	$28					
Treatment System O&M Cost (Percent)	5					
Collection System O&M Cost ($ Annum/Mile)	$3,600					
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	1.00					
Disposal System Construction Cost ($/Acre)	$350,000					
Land Cost ($/Acre)	$10,000					
Wastewater Production (Gal/Day-Person)	100					
Residents Per Household	2.3					
Collection System Percent Publically Financed	100.0					
Sub-Region Name	**West Belgrade**	**Belgrade Facility Plan**	**Jackrabbit**	**Valley Center**	**NW Bozeman**	**Four Corners**
Sub-Region Est. 20 Year Population	7,316	5600 of 13,300 Total	1,748	6,130	2,653	5,000
Sub-Region Est. Current Population	5,881	990 of 8690 Total	223	2,309	350	3,692
Capital Cost Calculations--Treatment & Disposal						
Connections	3,181	2,435	760	2,665	1,153	2,174
Wastewater Flowrate (Gal/Day)	731,600	560,000	174,800	613,000	265,300	500,000
Land Required For Treatment & Disposal Facilities	28	22	7	24	10	19
Central Treatment Facility Cost	$20,484,800	$15,680,000	$4,894,400	$17,164,000	$7,428,400	$14,000,000
Disposal Facility Cost	$5,878,329	$4,499,541	$1,404,500	$4,925,390	$2,131,657	$4,017,447
Land Cost	281,192	215,237	67,185	235,608	101,969	192,176
Subtotal Treatment & Disposal	26,644,321	20,394,778	6,366,084	22,324,998	9,662,026	18,209,624
Capital Cost Calculations--Collection System						
Collection System Cost	$25,121,094	$14,368,318	$5,495,893	$15,430,347	$4,754,113	13,945,460
Public Financing Factor (%)	100	100	100	100	100	100
Subtotal Publically Financed Collection	25,121,094	14,368,318	5,495,893	15,430,347	4,754,113	13,945,460
Right of Way Acquisition @ 2%	$502,422	$287,366	$109,918	$308,607	$95,082	$278,909
Subtotal Collection	$25,623,516	$14,655,684	$5,605,811	$15,738,954	$4,849,195	$14,224,369
Total of Possible Capital Costs	$52,267,837	$35,050,462	$11,971,895	$38,063,952	$14,511,221	$32,433,993
Annualized Cost Estimate						
Grant Allowance	($850,000)	($850,000)	($850,000)	($850,000)	($850,000)	($850,000)
Debt or Loan	$51,417,837	$34,200,462	$11,121,895	$37,213,952	$13,661,221	$31,583,993
Debt or Loan Reserve	$3,990,024	$2,653,956	$863,059	$2,887,803	$1,060,111	$2,450,918
20 Year Bond or Loan 3.75%	$55,407,861	$36,854,418	$11,984,955	$40,101,755	$14,721,332	$34,034,910
Annual Payment for Debt Service	$3,990,024	$2,653,956	$863,059	$2,887,803	$1,060,111	$2,450,918
Annual Treatment System O&M	$1,332,216	$1,019,739	$318,304	$1,116,250	$483,101	$910,481
Annual Collection System O&M	$99,150	$97,809	$20,582	$60,818	$60,818	$18,439
Subtotal of Annual Costs	$5,421,390	$3,771,504	$1,201,946	$4,064,871	$1,604,030	$3,379,838
Treatment & Disposal Debt Service ($/connection-year)	$646	$639	$609	$641	$616	$638
Collection Debt Service	$609	$450	$526	$443	$303	$489
Collection, Treatment & Disposal O&M	$450	$459	$446	$442	$472	$427
Total	$1,704	$1,549	$1,582	$1,525	$1,391	$1,555

Table 4A-3
Gallatin County Regional WW Study Phase 2
Collection, Treatment, & Disposal Spreadsheet
Subregions Considered Separately

Input Data						
Treatment System Construction Cost ($/Gal-Day of Capacity)	$22					
Treatment System O&M Cost (Percent)	5					
Collection System O&M Cost ($ Annum/Mile)	$3,600					
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	1.00					
Disposal System Construction Cost ($/Acre)	$350,000					
Land Cost ($/Acre)	$10,000					
Wastewater Production (Gal/Day-Person)	100					
Residents Per Household	2.3					
Collection System Percent Publically Financed	30.0					
Sub-Region Name	**West Belgrade**	**Belgrade Facility Plan**	**Jackrabbit**	**Valley Center**	**NW Bozeman**	**Four Corners**
Sub-Region Est. 20 Year Population	7,316	5600 of 13,300 Total	1,748	6,130	2,653	5,000
Sub-Region Est. Current Population	5,881	990 of 8690 Total	223	2,309	350	3,692
Capital Cost Calculations--Treatment & Disposal						
Connections	3,181	2,435	760	2,665	1,153	2,174
Wastewater Flowrate (Gal/Day)	731,600	560,000	174,800	613,000	265,300	500,000
Land Required For Treatment & Disposal Facilities	28	22	7	24	10	19
Central Treatment Facility Cost	$16,095,200	$12,320,000	$3,845,600	$13,486,000	$5,836,600	$11,000,000
Disposal Facility Cost	$5,878,329	$4,499,541	$1,404,500	$4,925,390	$2,131,657	$4,017,447
Land Cost	281,192	215,237	67,185	235,608	101,969	192,176
Subtotal Treatment & Disposal	22,254,721	17,034,778	5,317,284	18,646,998	8,070,226	15,209,624
Capital Cost Calculations--Collection System						
Collection System Cost	$25,121,094	$14,368,318	$5,495,893	$15,430,347	$4,754,113	13,945,460
Public Financing Factor (%)	30	30	30	30	30	30
Subtotal Publically Financed Collection	7,536,328	4,310,495	1,648,768	4,629,104	1,426,234	4,183,638
Right of Way Acquisition @ 2%	$150,727	$86,210	$32,975	$92,582	$28,525	$83,673
Subtotal Collection	$7,687,055	$4,396,705	$1,681,743	$4,721,686	$1,454,759	$4,267,311
Total of Possible Capital Costs	$29,941,776	$21,431,484	$6,999,028	$23,368,685	$9,524,985	$19,476,934
Annualized Cost Estimate						
Grant Allowance	($850,000)	($850,000)	($850,000)	($850,000)	($850,000)	($850,000)
Debt or Loan	$29,091,776	$20,581,484	$6,149,028	$22,518,685	$8,674,985	$18,626,934
Debt or Loan Reserve	$2,257,522	$1,597,123	$477,165	$1,747,450	$673,179	$1,445,450
20 Year Bond or Loan 3.75%	$31,349,298	$22,178,607	$6,626,192	$24,266,135	$9,348,164	$20,072,384
Annual Payment for Debt Service	$2,257,522	$1,597,123	$477,165	$1,747,450	$673,179	$1,445,450
Annual Treatment System O&M	$1,112,736	$851,739	$265,864	$932,350	$403,511	$760,481
Annual Collection System O&M	$99,150	$97,809	$20,582	$60,818	$60,818	$18,439
Subtotal of Annual Costs	$3,469,408	$2,546,671	$763,611	$2,740,618	$1,137,508	$2,224,370
Treatment & Disposal Debt Service ($/connection-year)	$530	$523	$479	$525	$496	$521
Collection Debt Service	$180	$132	$149	$130	$88	$143
Collection, Treatment & Disposal O&M	$381	$390	$377	$373	$403	$358
Total	$1,091	$1,046	$1,005	$1,028	$986	$1,023

SECTION B
SCREENING OF ALTERNATIVE NO.1
WEST BELGRADE CENTRAL COLLECTION AND TREATMENT

1. DESCRIPTION AND LOCATION

As shown previously in Figure 4A-1, the West Belgrade sub region is located immediately west and north of the City of Belgrade facility planning boundary and extends from Cameron Bridge Road in the south to Weaver Road in the north. This sub region includes the River Rock, Landmark, High-K, and 4 Dot subdivisions. With a currently estimated population of 5881 persons, and continued strong future growth, this mostly un-sewered (exception River Rock) population base makes this sub region well suited for central service or to become the initial phase of a larger system eventually serving multiple sub regions. In addition, this region is situated close to a large number of potential effluent disposal sites.

2. POPULATION SUMMARY

2010 Equivalents	5,881	
2030 Equivalents	7,316 (+24%)	
Max. Equivalents	14,998 (+155%)	Based On Current Zoning
Connections-Year 2030	3,181	2.3 Equiv./Connection
Wastewater Generated In 2030	732,000	Gallons/Day

3. ESTIMATED ANNUALIZED COST-YEAR 2030

Cost Per Connection/Year	$1091 to $1704

4. GENERAL FACILITY REQUIREMENTS & CONSIDERATIONS

Sewer Trunk Line

The approximate location of a main trunk sewer servicing the West Belgrade sub-region is shown in Figure 4B-1 as a hatched black line. The route selection was made with the intention of coming within one mile of existing and likely future high density areas and running to the most likely disposal areas located north of I-90 and south of Weaver Road. At least one major crossing of I-90 is required as well as numerous other un-quantified minor crossings.

Trunk line routing criteria also reflected an awareness of a possible future connection to a larger regional system. For example, the trunk line shown in the far northeast section of this sub region could be connected to a regional line that someday services eastern areas of the Belgrade planning area as well as the Valley Center and Northwest Bozeman sub regions. (Please note that combining sub regions into larger regional systems is considered in later sections of this report.)

Treatment & Disposal Areas

A composite GIS map of disposal constraints is shown in Figure 4B-2. Areas that meet the minimum depth to groundwater and hydraulic conductivity criteria are shown on the map in purple. As shown in the constraints map, this sub region has a large amount of potential (purple) disposal sites.

In addition to meeting these criteria, the distance between any disposal site and down gradient surface waters or public water supply wells, should be maximized to reduce potential impacts. Existing subdivisions, neighborhoods, and commercial areas should also be avoided where possible. An aerial map showing landforms and structures is shown in Figure 4B-3. This figure can be used to refine possible disposal site locations by considering the location of physical interferences. Based on a combined review of both the constraints map and aerial photograph, potential disposal sites are located within the far north portions of the sub region just south and parallel to Weaver Road. This alternative requires approximately 30 acres of land; the map key indicates the relative size of the required parcel.

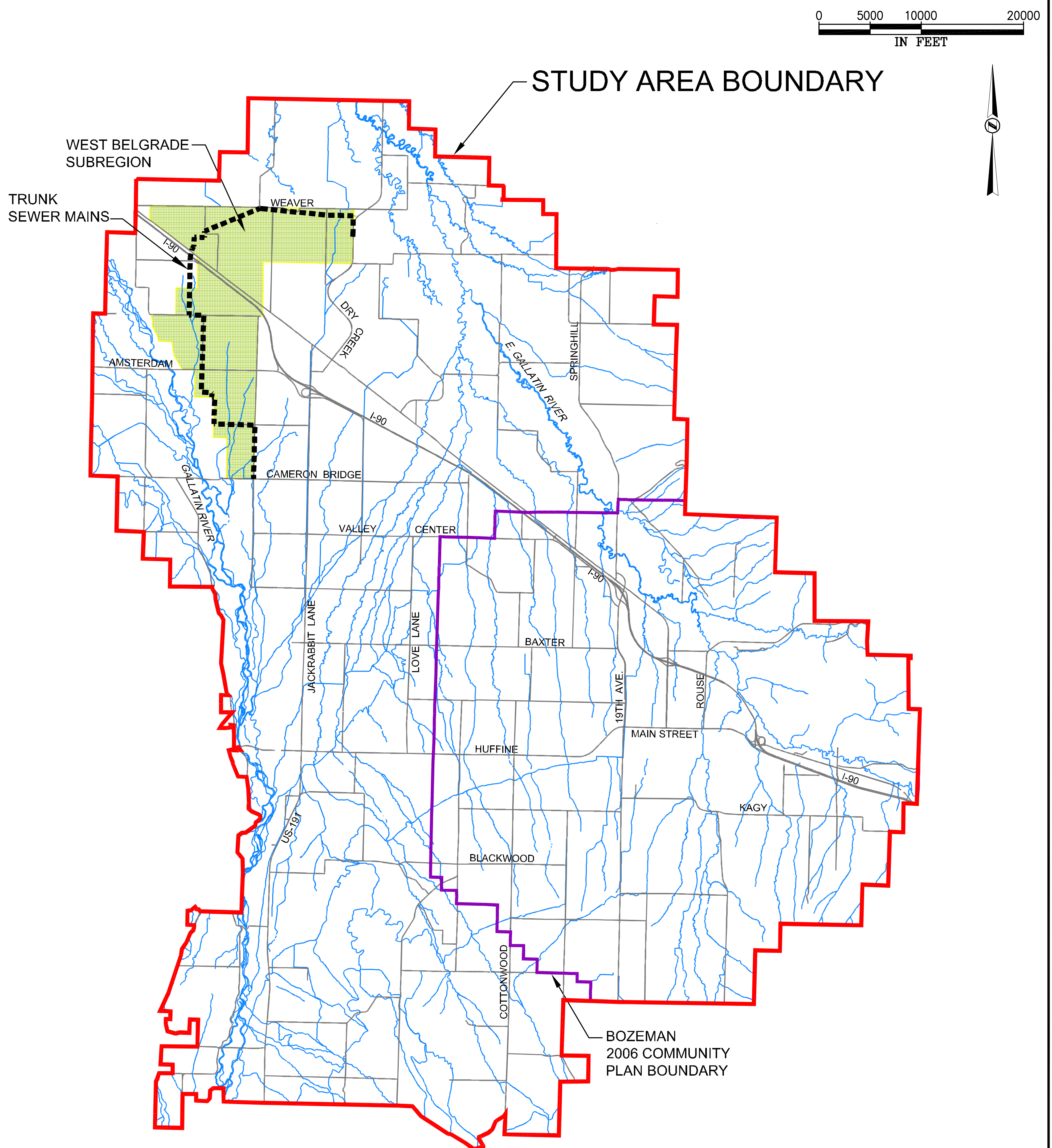
In addition, potential disposal sites exist south of the River Rock subdivision including some sites just outside of the sub region boundaries. Using the southern sites in this alternative would require pumping from north to south. As a result, the northern sites should be pursued first with the southern sites considered as contingencies or for other sub regions that may be site limited.

Water Rights

According to the previously presented discussion on water rights, the transport of effluent may be prevented by mitigation requirements of certain water rights established after 2003. The existing service area population is approximately 5880 persons which equates to about 588,000 gallons per day. This effluent volume can likely be conveyed and disposed within the sub region without complication. The ability to transport and dispose of the remaining effluent would depend on the nature of the water rights used to supply drinking water to those customers. That evaluation is beyond the scope of this evaluation.

Facility Summary

Flow Rate:	732,000 Gallons/Day
Treatment Level:	Group 5 Nitrogen Removal
Disposal:	Groundwater Discharge
Land Required:	28 Acres
Permit:	Montana groundwater pollution control permit
Water Quality:	Groundwater discharge mixing zone cannot intersect surface water



NOTES:

1. GIS DATA SUPPLIED BY GALLATIN COUNTY GIS DEPARTMENT VIA GALLATIN COUNTY PLANNING DEPARTMENT. SHOWN IN MONTANA STATE PLANE (FEET).

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FIG. 4B-1

SHEET

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CHECKED RMS
DATE 9/15/2010

WEST BELGRADE CCT

REGIONAL WASTEWATER TREATMENT FEASIBILITY STUDY, PHASE 2
GALLATIN COUNTY, MONTANA

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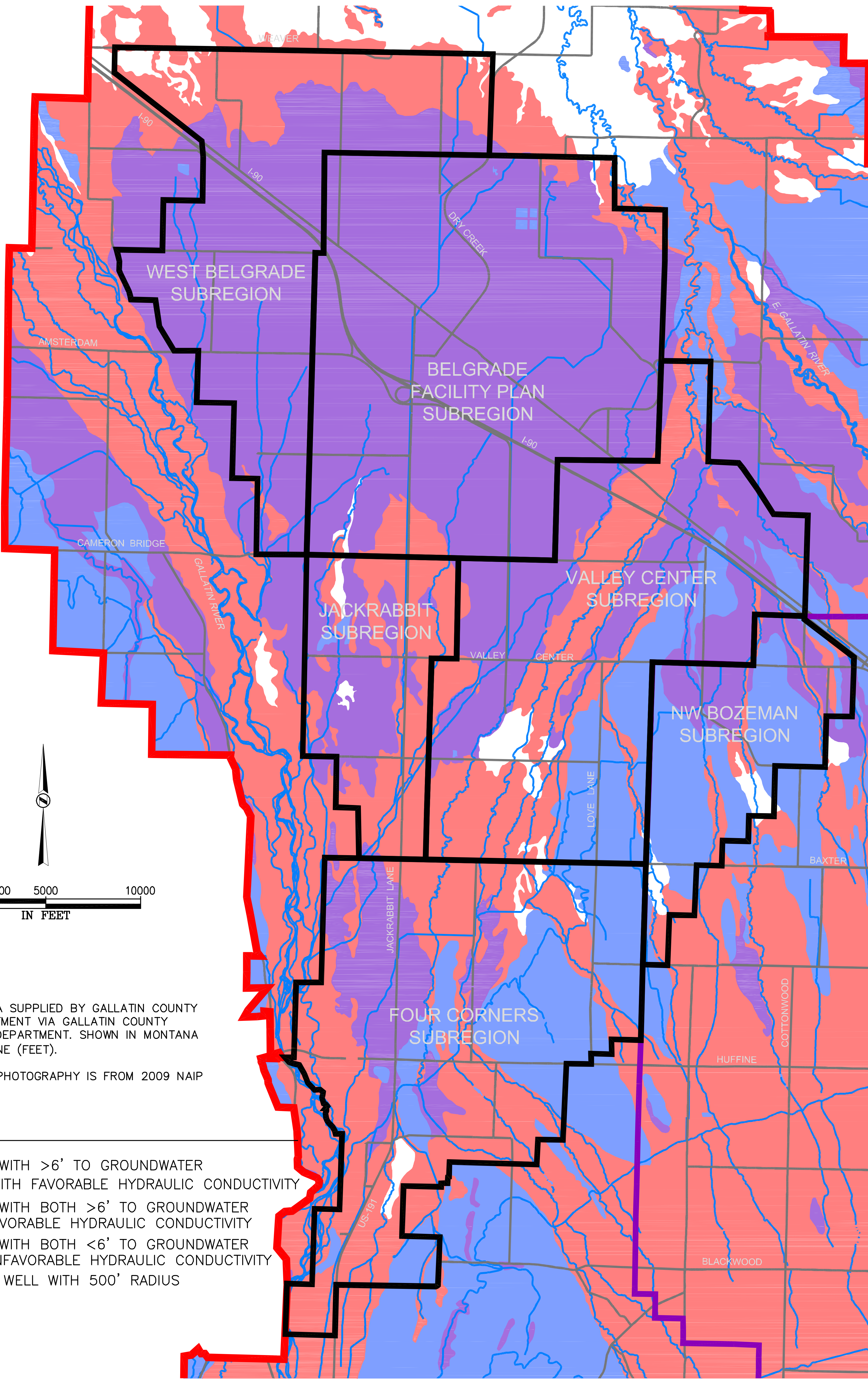

NOTES:

1. GIS DATA SUPPLIED BY GALLATIN COUNTY GIS DEPARTMENT VIA GALLATIN COUNTY PLANNING DEPARTMENT. SHOWN IN MONTANA STATE PLANE (FEET).

2. AERIAL PHOTOGRAPHY IS FROM 2009 NAIP IMAGERY.

KEY

- AREAS WITH >6' TO GROUNDWATER
- AREA WITH FAVORABLE HYDRAULIC CONDUCTIVITY
- AREAS WITH BOTH >6' TO GROUNDWATER AND FAVORABLE HYDRAULIC CONDUCTIVITY
- AREAS WITH BOTH <6' TO GROUNDWATER AND UNFAVORABLE HYDRAULIC CONDUCTIVITY
- PUBLIC WELL WITH 500' RADIUS

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FIG. 4B-2

SHEET

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SUBREGIONS DISPOSAL CONSTRAINTS - ENLARGED

REGIONAL WASTEWATER TREATMENT FEASIBILITY STUDY, PHASE 2
GALLATIN COUNTY, MONTANA

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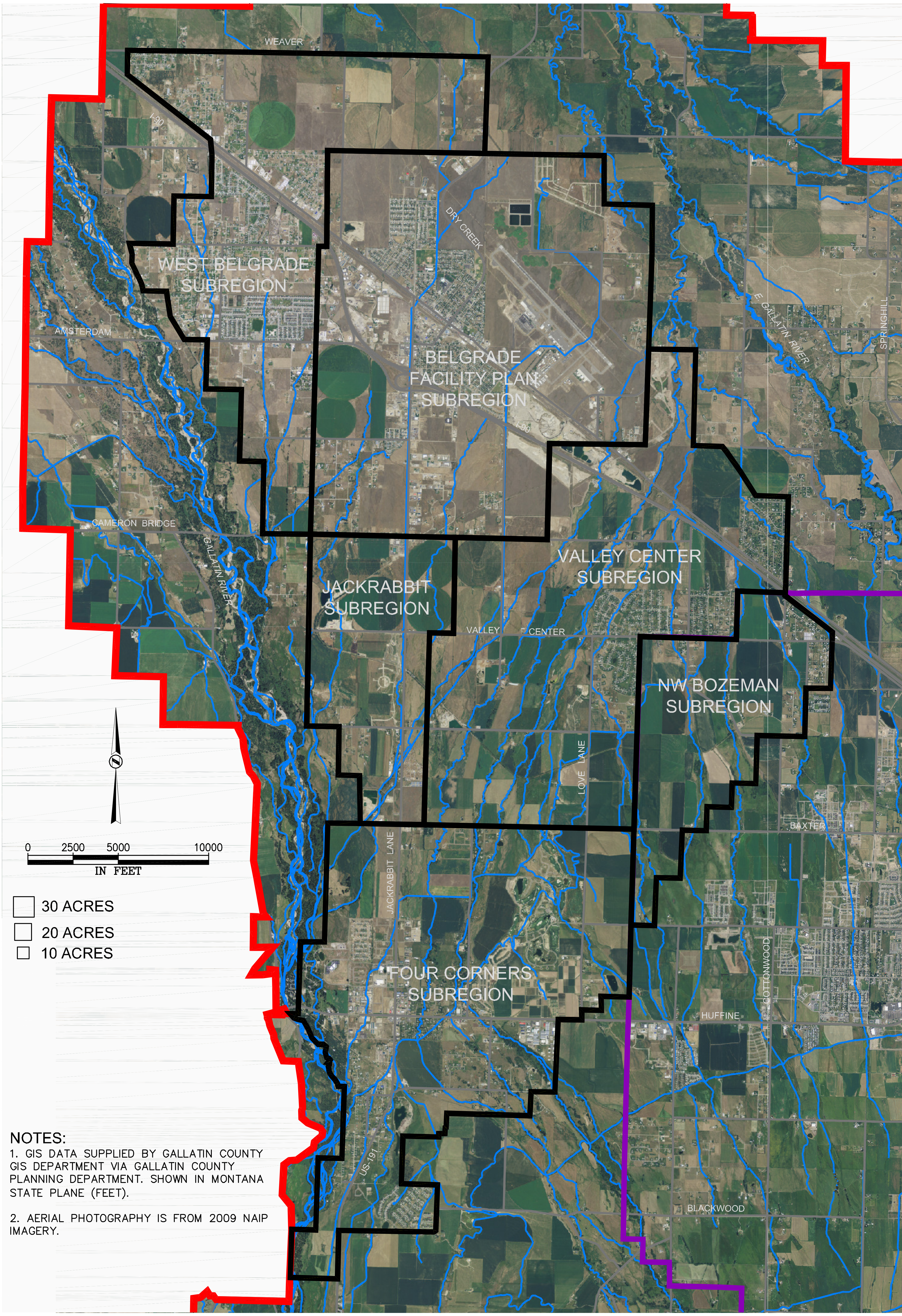
N:\0939-01809 GALLATIN COUNTY WW STUDY PH2\dwg\Figures\Fig -4B-3 Subregion Aerial enlrg.dwg, FIG-4B-3 PHOTO, Plotted: Sep 15, 2010 - 2:22pm, brickert



NOTES:

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2. AERIAL PHOTOGRAPHY IS FROM 2009 NAIP IMAGERY.

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SHEET FIG. 4B-3

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SUBREGIONS AERIAL ENLARGEMENT

REGIONAL WASTEWATER TREATMENT FEASIBILITY STUDY, PHASE 2 GALLATIN COUNTY, MONTANA

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SECTION C
SCREENING OF ALTERNATIVE NO.2
BELGRADE FACILITY PLAN AREA CENTRAL COLLECTION AND TREATMENT

1. DESCRIPTION AND LOCATION

As shown previously in Figure 4A-1, the Belgrade Facility Plan sub-region surrounds and includes the Belgrade city limits. With a currently estimated population of 8690 persons, and continued strong future growth, this area includes a significant user base plus a large amount of un-sewered land located outside the city limits but inside the sub-region. As was the case for West Belgrade, this sub region is well suited for expanded central service or to become part of a larger system eventually serving multiple sub-regions. This area is also conveniently located near a large number of potential effluent disposal sites.

The City of Belgrade's existing treatment and disposal facility has a permitted discharge volume and existing non-degradation limits that are advantageous for the City. Therefore, we assume that the existing collection and treatment facilities will remain separate from any future county facilities. As a result, alternatives that consider this sub-region are focused on service opportunities for new growth above the existing population of approximately 7700 persons. Over the next 20 years, new growth could amount to 5600 equivalents bringing the total sub-region population to 13,300 persons. This analysis assumes that most new growth will occur outside the city limits and inside the planning area boundary. Making this assumption allows us to project that 5600 equivalents will require centralized sewer service by 2030.

Note: This alternative is conceptual in nature and is intended to demonstrate possible regional concepts. It has not been reviewed by or endorsed by the City of Belgrade.

2. POPULATION SUMMARY

2010 Equivalents	7,700 Within City Limits 8,690 Within Planning Area	7700 Currently Served by City of Belgrade Sewer System
2030 Equivalents	7,700 Within City Limits + 5,600 Outside City Limits For a Total of 13,300 Equivalents	5,600 Of New Growth is Assumed to be Served by a County Facility
Max. Equivalents	29,287	Based On Current Zoning
Connections-Year 2030	2434	2.3 Equiv. /Connection. New Growth Only.
Wastewater Generated In 2030	560,000	Gallons/Day

3. ESTIMATED ANNUALIZED COST-YEAR 2030

Cost Per Connection/Year	$1,050 to $1,550	For the 5,600 of New Growth Outside City Limits

4. GENERAL FACILITY REQUIREMENTS AND CONSIDERATIONS

Sewer Trunk Line

The approximate location of a main trunk sewer servicing this sub-region is shown in Figure 4C-1 as a hatched black line. As shown, this area could be served by the West Belgrade sub-region trunk line (See Alternative 2.) plus several smaller laterals which are also marked on the diagram. The route selection for this alternative was made with the intention of coming within one mile of existing and likely future high density areas and running to the most likely disposal areas located north of I-90 and south of Weaver Road. At least one major crossing of I-90 is required as well as numerous other un-quantified minor crossings.

Trunk line routing criteria also reflected an awareness of a possible future connection to a larger regional system involving West Belgrade or possible combinations with other sub-regions. Please note that combining sub regions into larger regional systems is considered in later sections of this report.

Treatment & Disposal Areas

A composite GIS map of disposal constraints was previously shown in Figure 4B-2. Areas that meet the minimum depth to groundwater and hydraulic conductivity criteria are shown on the map in purple. As shown on this map, the Belgrade and West Belgrade areas have many potential (purple) disposal sites.

The distance between any disposal site and down gradient surface waters or public water supply wells should be maximized to reduce potential impacts. Existing subdivisions, neighborhoods, and commercial areas should also be avoided where possible. An aerial map showing landforms and structures was previously shown in Figure 4B-3 and can be used to refine possible disposal site locations for this alternative. Based on a combined review of both the constraints map and aerial photograph, there are potential disposal sites that located within the far northwest portions of this sub region north of the frontage road. However, the majority of this land is located within the Belgrade city limits and was eliminated from further consideration.

As discussed in the previous alternative, a number of potential disposal sites can be found within the West Belgrade sub-region parallel to and north of Weaver Road. This general location has the combined advantage of good site conditions, potentially few constraints plus it is accessible to all sub-regions by gravity flow. Servicing this particular alternative would require a minimum of 22 acres.

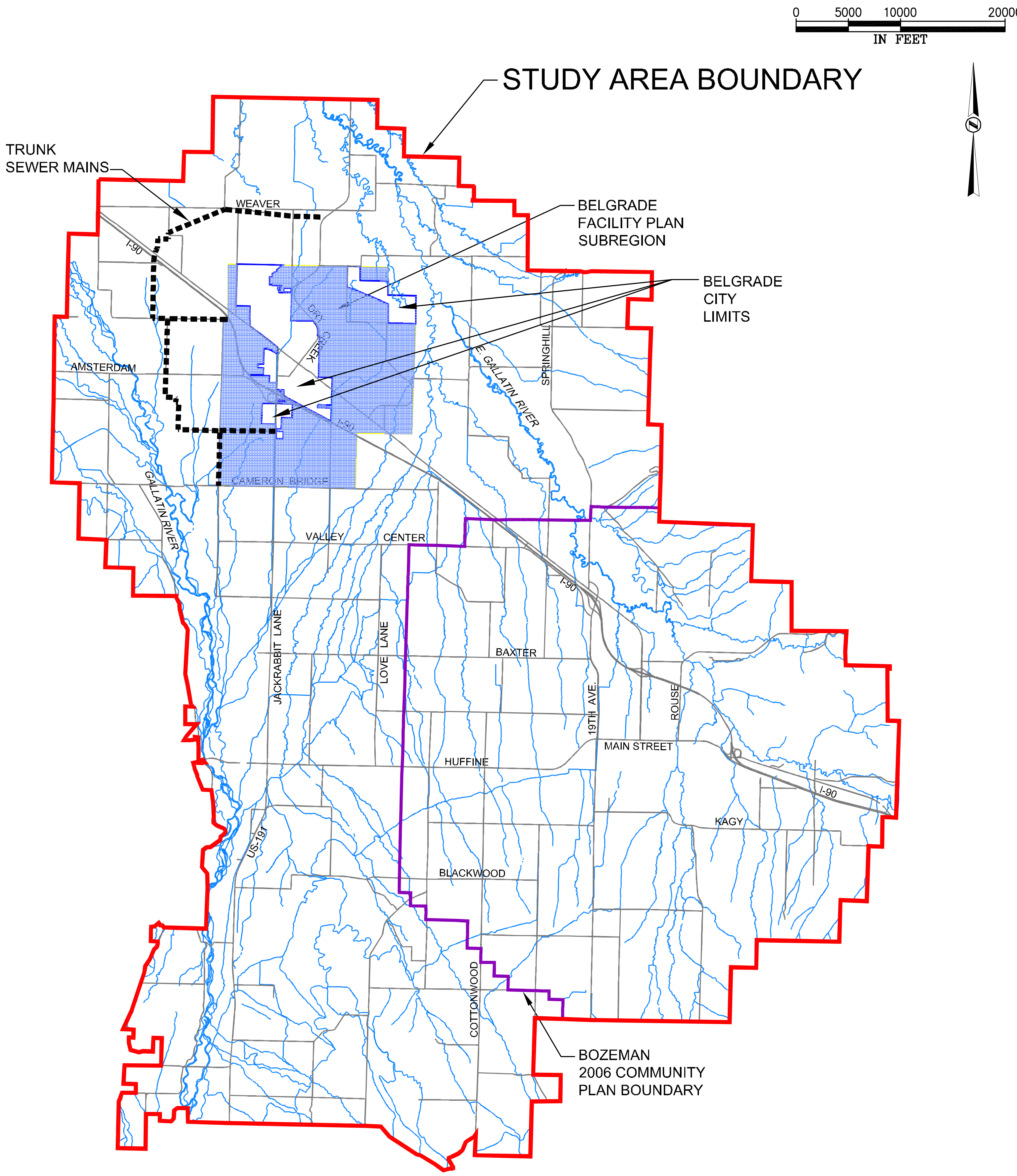
Water Rights

According to the previously presented discussion on water rights, the transport of effluent may be prevented by mitigation requirements of certain water rights established after 2003. Given the proximity of the proposed disposal area to the service area, encountering water rights complications appears to be unlikely for this alternative. Although this alternative appears to benefit from a favorable water rights situation, further analysis is necessary to establish what mitigation requirements would apply to the drinking water supply to future customers. That evaluation is beyond the scope of this project.

Facility Summary

Flow Rate:	560,000 Gallons/Day
Treatment Level:	Group 5 Nitrogen Removal
Disposal:	Groundwater Discharge
Land Required:	22 Acres
Permit:	Montana groundwater pollution control permit
Water Quality:	Groundwater discharge mixing zone cannot intersect surface water

N:\0939-01809 GALLATIN COUNTY WW STUDY PH2\dwg\Figures\Fig -4C-1 Belgrade Facility Area CCT.dwg, FIG-4C-1 W BELGRADE FACILITY CCT, Plotted: Sep 15, 2010 - 2:23pm, brickert



NOTES:

1. GIS DATA SUPPLIED BY GALLATIN COUNTY GIS DEPARTMENT VIA GALLATIN COUNTY PLANNING DEPARTMENT. SHOWN IN MONTANA STATE PLANE (FEET).

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SHEET FIG. 4C-1

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BELGRADE FACILITY PLAN AREA CCT

REGIONAL WASTEWATER TREATMENT FEASIBILITY STUDY, PHASE 2
GALLATIN COUNTY, MONTANA

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SECTION D
SCREENING OF ALTERNATIVE NO.3
JACKRABBIT CENTRAL COLLECTION AND TREATMENT

1. DESCRIPTION AND LOCATION

The proposed Jackrabbit sub-region was shown along with the other sub-regions in Figure 4A-1. This sub-region is located immediately north of Belgrade planning boundary on either side of Jackrabbit lane. The sub-region is bounded on the north by Cameron Bridge Road and on the northern boundary by Baxter lane. With an abundance of undeveloped property, this 2300 acre area is projected to absorb a significant amount of future study area growth. With a currently estimated population of 223 persons, and current zoning classifications, this area could increase by eight fold over the next 20 years. The reader should note that the existing Gallatin Heights subdivision is excluded from this analysis because it is already connected to Utility Solutions with a force main sewer.

This area is illustrative of the paradoxes surrounding central facility planning for the study area. Although the current density appears incapable of supporting much infrastructure, the existing zoning will eventually result in very high sub-regional growth rates. Without central facilities, a mosaic of decentralized systems will result as the area grows. With centralized service, the same density will also be realized but with less overall cost to residents (compared to decentralized systems) and also with less environmental degradation.

Because of high potential growth and currently low density, The Jackrabbit sub-region is somewhat of a “clean slate” from a planning standpoint. This area could be planned for either a sub-regional wastewater system or for the future connection to a larger regional system sometime in the future. This particular alternative examines the sub-regional collection, treatment, and disposal systems. Jackrabbit is considered as part of a larger regional system in later alternatives.

2. POPULATION SUMMARY

2010 Equivalents	223	
2030 Equivalents	1,748 (+700%)	
Max. Equivalents	9,910 (+4,300%)	Based On Current Zoning
Connections-Year 2030	760	2.3 Equiv./Connection
Wastewater Generated in 2030	175,000	Gallons/Day

3. ESTIMATED ANNUALIZED COST-YEAR 2030

Cost Per Connection/Year	$1,000 to $1,580

4. GENERAL FACILITY REQUIREMENTS & CONSIDERATIONS

Sewer Trunk Line

The approximate location of a main trunk sewer servicing the Jackrabbit sub-region is shown in Figure 4D-1 as a hatched black line. The route selection was made with the intention of coming within one mile of existing and future high density areas with gravity flow to potential disposal areas. Trunk line routing criteria also reflected an awareness of a possible future connection to a larger regional system.

Treatment & Disposal Areas

A composite GIS map of disposal constraints was shown in Figure 4B-2. Areas that meet the minimum depth to groundwater and hydraulic conductivity criteria are shown on the map in purple. In addition to meeting these criteria, the distance between any disposal site and down gradient surface waters or public water supply wells, should be maximized to reduce potential impacts. Existing subdivisions, neighborhoods, and commercial areas should also be avoided where possible. An aerial map showing landforms and structures was shown in Figure 4B-3. This figure can be used to refine possible disposal site locations by considering the location of physical interferences.

The treatment and disposal facilities serving this sub-region require a minimum of 7 acres of suitable land. Based on a combined review of both the constraints map and aerial photograph, potential disposal sites are located the far northwest portion of the sub region south of Cameron Bridge Road. However, this area may encroach upon surface water. A better choice may be lands located west and outside of the sub-region boundary and south of Cameron Bridge Road. In this location, the sites are larger and further from surface waters.

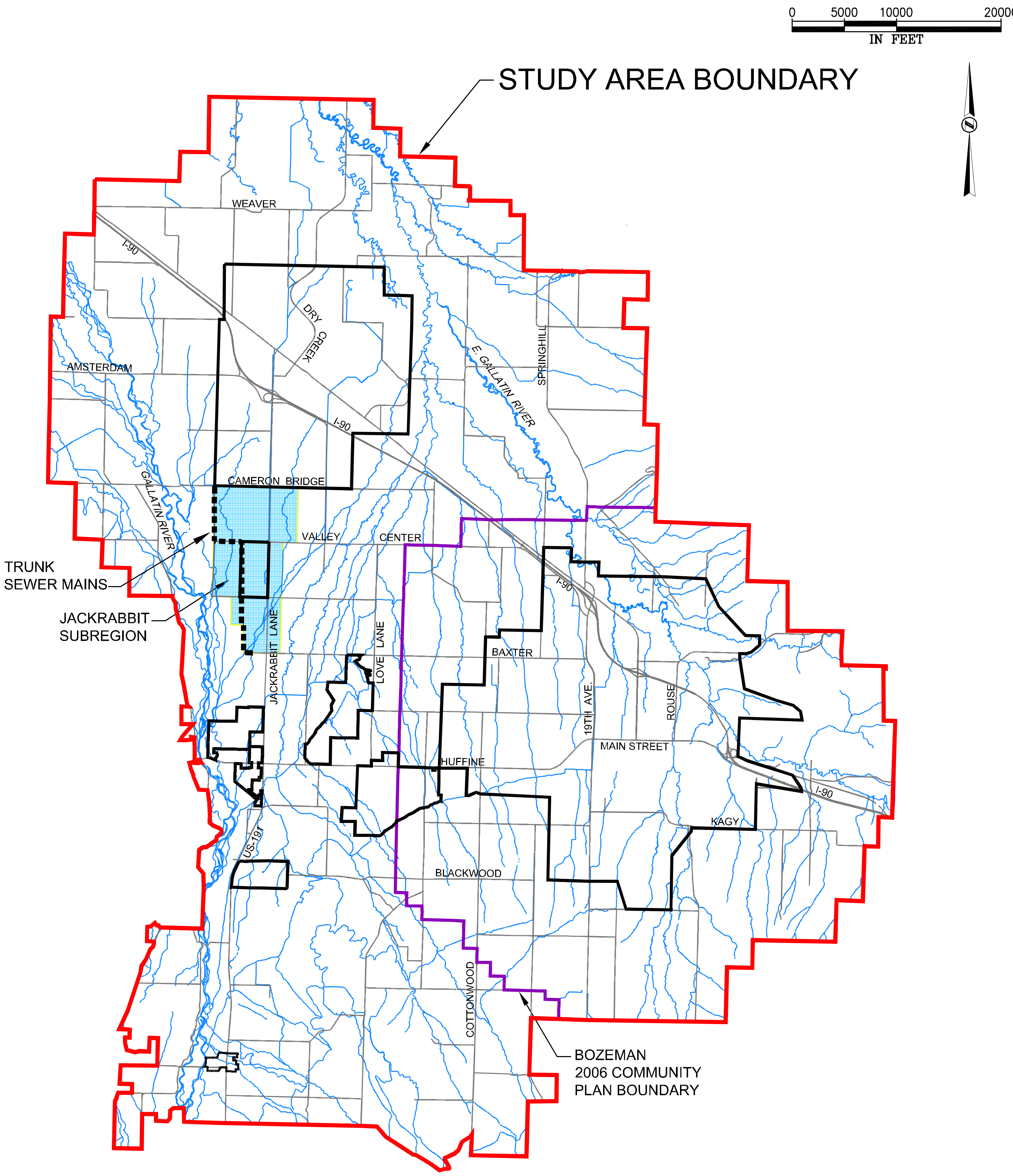
There are also disposal opportunities available within the Valley Center sub-region south of the Belgrade Facility Plan Boundary and west of Alaska Road. Taking advantage of these sites would require that the trunk sewer be re-routed from its optimal location in the northwest corner and run to the northeast sub-region corner. While feasible for a sub-regional facility, this configuration would not be optimal for connection to a larger regional system.

Water Rights

According to the previously presented discussion on water rights, the transport of effluent may be prevented by mitigation requirements of certain water rights established after 2003. Given the proximity of the proposed disposal area to the service area, encountering water rights complications appears to be unlikely for this alternative. Although this alternative appears to benefit from a favorable water rights situation, further analysis is necessary to establish what mitigation requirements would apply to the drinking water supply to future customers. That evaluation is beyond the scope of this project.

Facility Summary

Flow Rate:	175,000 Gallons/Day
Treatment Level:	Group 5 Nitrogen Removal
Disposal:	Groundwater Discharge
Land Required:	7 Acres
Permit:	Montana groundwater pollution control permit
Water Quality:	Groundwater discharge mixing zone cannot intersect surface water



NOTES:

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FIG. 4D-1

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JACKRABBIT CCT

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SECTION E
SCREENING OF ALTERNATIVE NO.4
VALLEY CENTER CENTRAL COLLECTION AND TREATMENT

1. DESCRIPTION AND LOCATION

The Valley Center sub-region is located east of the Jackrabbit sub region and west of the City of Bozeman community plan boundary. The southern boundary is Baxter lane. Encompassing 6130 net acres excluding the Valley Grove subdivision, this area is the largest of the sub-regions. Given the current land use and zoning classifications, the current population of 2300 persons could increase to 6100 during the next 20 years.

2. POPULATION SUMMARY

2010 Equivalents	2309	
2030 Equivalents	6,130 (+165%)	
Max. Equivalents	26,735 (+1057%)	Based On Current Zoning
Connections-Year 2030	2,665	2.3 Equiv./Connection
Wastewater Generated in 2030	613,000	Gallons/Day

3. ESTIMATED ANNUALIZED COST-YEAR 2030

Cost Per Connection/Year	$1028 to $1,525

4. GENERAL FACILITY REQUIREMENTS AND CONSIDERATIONS

Sewer Trunk Line

The approximate location of a main trunk sewer servicing the Valley Center sub-region is shown in Figure 4E-1 as a hatched black line. The route selection was made with the intention of coming within one mile of existing and future high density areas with gravity flow to potential disposal areas. Trunk line routing criteria also reflects possible future connections with the Northwest Bozeman Facility Plan Area and localized drainage pathways within this sub-region.

Treatment & Disposal Areas

A composite GIS map of disposal constraints was shown in Figure 4B-2. Areas that meet the minimum depth to groundwater and hydraulic conductivity criteria are shown on the map in purple. In addition to meeting these criteria, the distance between any disposal site and down gradient surface waters or public water supply wells, should be maximized to reduce potential impacts. Existing subdivisions, neighborhoods, and commercial areas should also be avoided where possible. An aerial map showing landforms and structures was shown in Figure 4B-3. This figure can be used to refine possible disposal site locations by considering the location of physical interferences.

The treatment and disposal facilities serving this sub-region require a minimum of 24 acres of suitable land. Based on an inspection of the drawings, a limited amount of suitable disposal areas are available in the northern portion of this sub-region. The first area is located south of Belgrade Facility Plan Boundary and west of Alaska Road. One potential problem with this area is that the far-northern portions of this sub-region including areas north of I-90 may require a lift station including a freeway crossing to access the disposal site. Additional disposal areas are also located just north and east of the interstate.

Water Rights

According to the previously presented discussion on water rights, the transport of effluent may be prevented by mitigation requirements of certain water rights established after 2003. Given the proximity of the proposed disposal area to the service area, encountering water rights complications appears to be unlikely for this alternative. Although this alternative appears to benefit from a favorable water rights situation, further analysis is necessary to establish what mitigation requirements would apply to the drinking water supply to future customers. That evaluation is beyond the scope of this project.

Facility Summary

Flow Rate:	613,000 Gallons/Day
Treatment Level:	Group 5 Nitrogen Removal
Disposal:	Groundwater Discharge
Land Required:	24 Acres
Permit:	Montana groundwater pollution control permit
Water Quality:	Groundwater discharge mixing zone cannot intersect surface water

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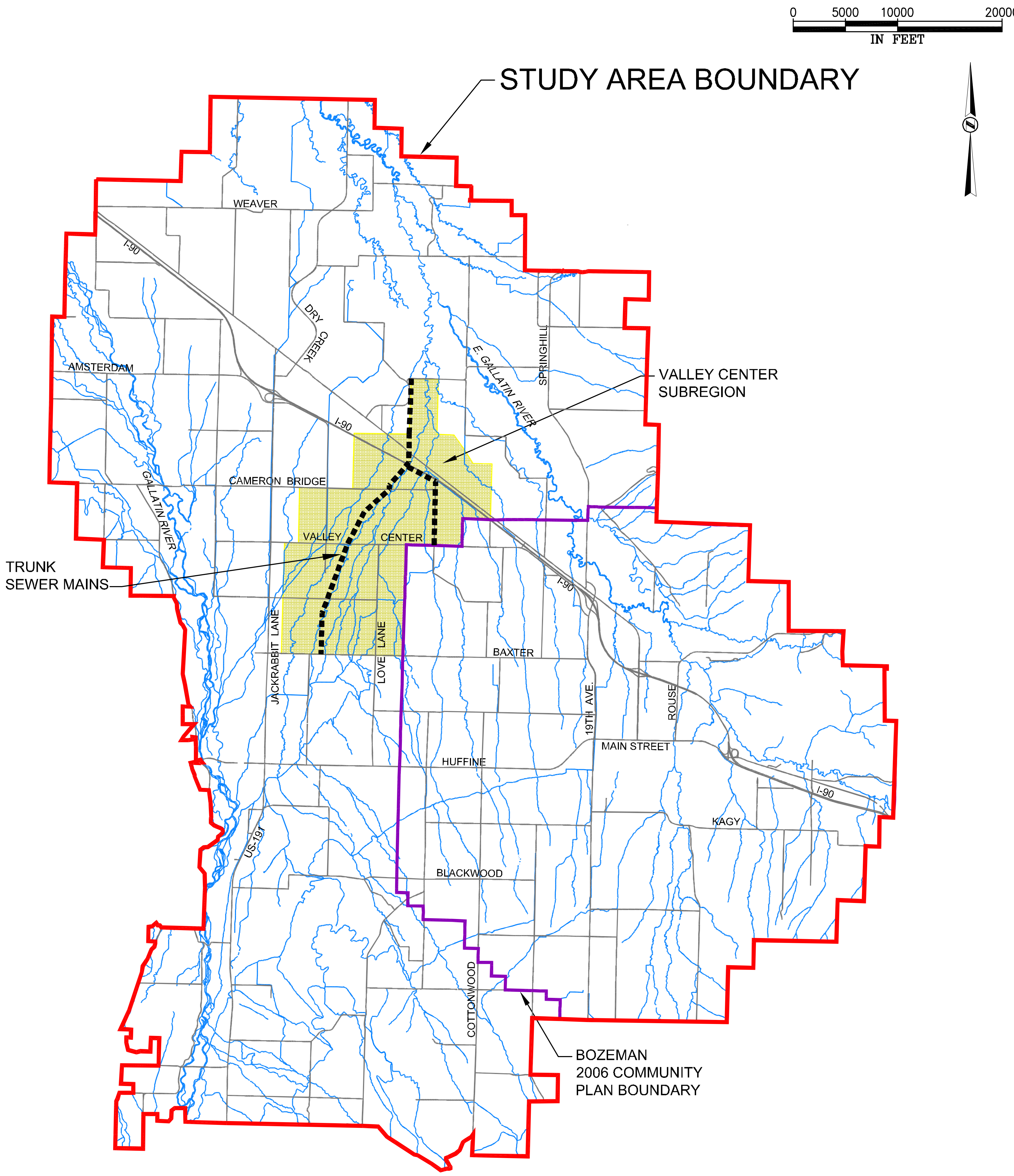

NOTES:

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FIG. 4E-1

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SECTION F
SCREENING OF ALTERNATIVE NO.5
NORTHWEST BOZEMAN CENTRAL COLLECTION AND TREATMENT

1. DESCRIPTION AND LOCATION

This sub-region lies in the extreme northwest corner of the City of Bozeman Community Plan boundary. Although part of the Bozeman Community Plan, Bozeman may allow this area to be serviced by a county facility in the event it would help facilitate central planning. At the present time, this area is sparsely populated. However, given the land use and zoning classifications, the current population of 350 persons could increase 7 fold over the next 20 years. The potential growth rate in this area is very similar to Jackrabbit and Valley center areas sub-region potential.

2. POPULATION SUMMARY

2010 Equivalents	350	
2030 Equivalents	2,653 (+658%)	
Max. Equivalents	15,071 (+4200%)	Based On Current Zoning
Connections-Year 2030	1,153	2.3 Equiv./Connection
Wastewater Generated In 2030	265,000	Gallons/Day

3. ESTIMATED ANNUALIZED COST-YEAR 2030

Cost Per Connection/Year	$1030 to $1,530

4. GENERAL FACILITY REQUIREMENTS & CONSIDERATIONS

Sewer Trunk Line

The approximate location of a main trunk sewer servicing the Valley Center sub-region is shown in Figure 4E-1 as a hatched black line. The route selection was made with the intention of coming within one mile of existing and future high density areas with gravity flow to potential disposal areas. Trunk line routing criteria also reflects possible future connections with the Northwest Bozeman Facility Plan Area and localized drainage pathways within this sub-region.

Treatment & Disposal Areas

A composite GIS map of disposal constraints was shown in Figure 4B-2. Areas that meet the minimum depth to groundwater and hydraulic conductivity criteria are shown on the map in purple. In addition to meeting these criteria, the distance between any disposal site and down gradient surface waters or public water supply wells, should be maximized to reduce potential impacts. Existing subdivisions, neighborhoods, and commercial areas should also be avoided where possible. An aerial map showing landforms and structures was shown in Figure 4B-3. This figure can be used to refine possible disposal site locations by considering the location of physical interferences.

The treatment and disposal facilities serving this sub-region require a minimum of 10 acres of suitable land. An inspection of constraint and aerial photo drawings indicates that suitable disposal locations accessible by gravity flow may not be available within the Northwest Bozeman sub-region. Although there are lands in the far northern portion, the locations are immediately up gradient of several public water supply wells serving the Valley Grove subdivision. Based on the proximity to these wells It would be unrealistic to think that a groundwater disposal system could be easily permitted in this location. Further to the northeast and south of the freeway there exist smaller parcels of favorable land that could support this disposal area. However, with several nearby developments, permitting would be difficult.

Other disposal opportunities may exist outside of the sub-region. As discussed in Alternative 4, suitable lands are located south of the Belgrade Facility Plan Boundary and west of Alaska Road. The most likely way to access this site is a gravity sewer running west along Valley Center road.

Water Rights

According to the previously presented discussion on water rights, the transport of effluent may be prevented by mitigation requirements of certain water rights established after 2003. Given the proximity of the proposed disposal area to the service area, encountering water rights complications appears to be unlikely for this alternative. Although this alternative appears to benefit from a favorable water rights situation, further analysis is necessary to establish what mitigation requirements would apply to the drinking water supply to future customers. That evaluation is beyond the scope of this project.

Facility Summary

Flow Rate:	265,000 Gallons/Day
Treatment Level:	Group 5 Nitrogen Removal
Disposal:	Groundwater Discharge
Land Required:	10 Acres
Permit:	Montana groundwater pollution control permit
Water Quality:	Groundwater discharge mixing zone cannot intersect surface water

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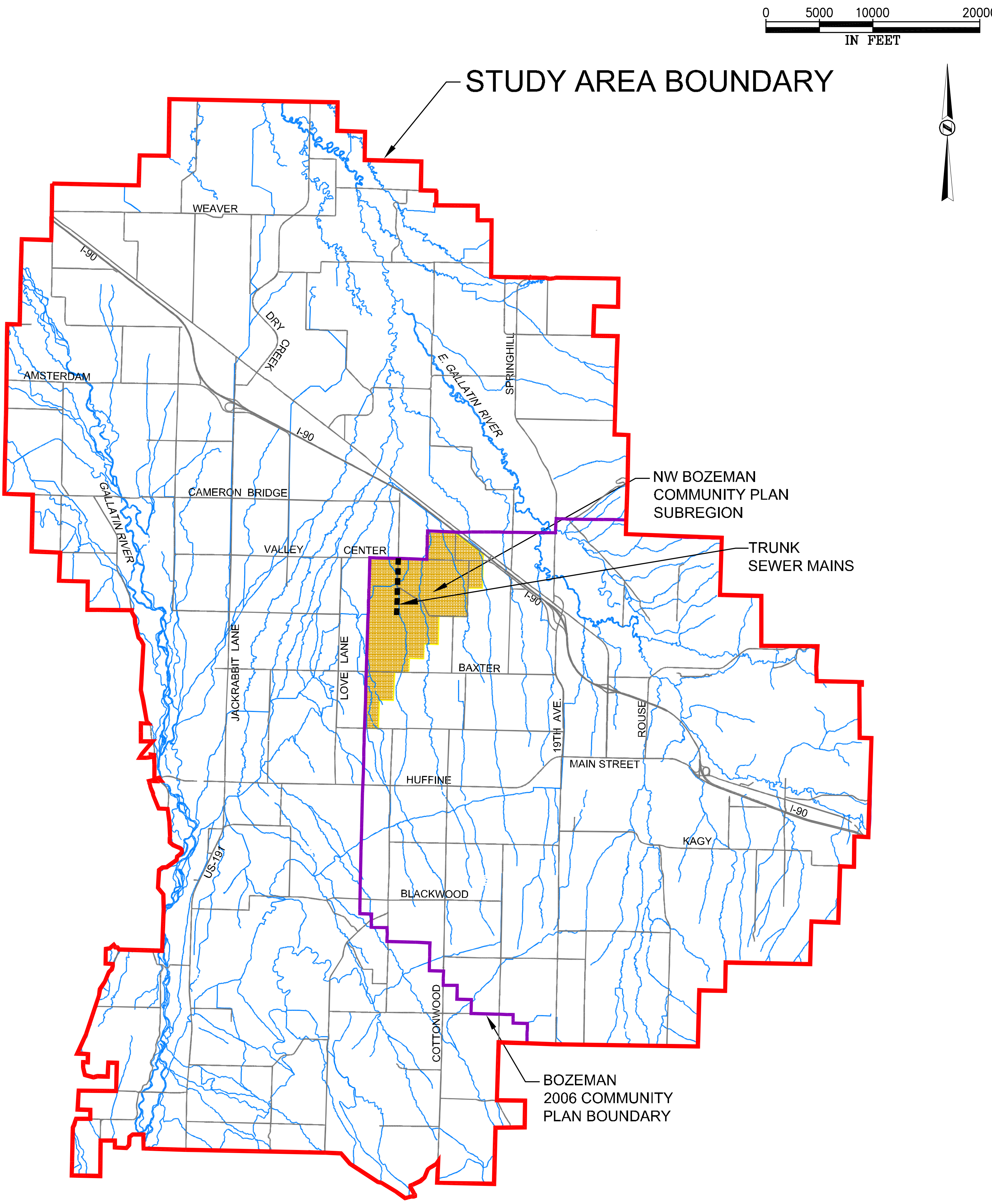

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FIG. 4F-1

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SECTION G
SCREENING OF ALTERNATIVE NO.6
FOUR CORNERS CENTRAL COLLECTION AND TREATMENT

1. DESCRIPTION AND LOCATION

As was shown in Figure 4A-1, this sub-region has Four Corners (the intersection of Huffine and US 191) as its approximate center. This sub-region extends from Baxter Lane in the north to the vicinity of Blackwood Road in the south. Within this area are lands currently served by the Utility Solutions sewer system as well as lands planned for future service by Utility Solutions. (Currently serviced areas are marked with a dark line on the maps.) The sub-region has approximately 3700 existing residents which, given its zoning, could almost double over the next 20 years.

The current Utility Solutions facility plan proposes a capacity of 700,000 gallons per day which is equivalent to about 7000 persons. This population is similar to our 2030 projection of 7310 for the entire sub-region. Without reviewing the facility plan in great detail, one alternative for this area may be continue with the Utility Solutions plan. However, recent proposals for the Four Corners Water & Sewer District to acquire Utility Solutions have stalled on concerns about ongoing costs and required debt levels. Until this situation is resolved, the status of future service in this sub-region remains uncertain.

Although the county scope of work specified that existing serviced areas be excluded from this analysis, the extent of existing sewer infrastructure makes it somewhat impractical to do so. An existing network of gravity and force main sewers serve Gallatin Heights (located in the Jackrabbit sub-region), North Star, Galactic Park, and the Black Bull subdivisions. Flows are collected at the North Star lift station and are then pumped to the Elk Grove treatment and disposal facility. This network is widely accessible to a large portion of the sub-region through the installation of more gravity neighborhood sewers and some lift stations. As a result, the two most likely scenarios are for the Utility Solutions and/or Four Corners WSD to continue the existing plan or for a county facility to provide service to all or part of the sub-region.

According to our estimates, approximately 2400 people currently reside within the sub-region but are not served by sewer. This number is expected to grow to about 5000 by the year 2030 unless additional neighborhood sewers are provided by the existing entities. The overall sub-regional population is expected to grow to about 7300 by the year 2030.

Note: This alternative is conceptual in nature and is intended to demonstrate possible regional concepts. It has not been reviewed by or endorsed by either Utility Solutions or the Four Corners Water and Sewer District

2. POPULATION SUMMARY

2010 Equivalents	1,267 Sewered by US 2,425 Un-sewered areas 3,692 Total in Subregion	US=Utility Solutions
2030 Equivalents	2,301 Sewered by US 5,000 Un-sewered areas 7,310 Total in Subregion (+100%)	
Max. Equivalents	26,674 Total Subregion	Based On Current Zoning
Connections-Year 2030	1,000 Sewered 2,174 Un-sewered	2.3 Equiv./Connection
Wastewater Generated In 2030	230,000 Sewered 500,000 Un-sewered	Gallons/Day

3. ESTIMATED ANNUALIZED COST-YEAR 2030

Cost Per Connection/Year	$1,020 to $1,555	5000 Equivalents
Cost Per Connection/Year	$980 to $1,400	7310 Equivalents

Note: The above costs do not reflect the value of the existing sub-regional collection infrastructure. As a result, actual costs may be lower than estimated.

4. GENERAL FACILITY REQUIREMENTS & CONSIDERATIONS

Sewer Trunk Line

An existing network of gravity and force main sewers serve Gallatin Heights (located in the Jackrabbit sub-region), North Star, Galactic Park, and the Black Bull subdivisions. Flows are collected at the North Star lift station and are then pumped to the Elk Grove treatment and disposal facility. This network is widely accessible to most of the sub-region through the installation of more gravity neighborhood sewers and some lift stations.

A county facility could be designed to accept all or part of the flows from the Four Corners sub-region with disposal occurring either within the sub-region or further north as part of a larger regional system. In any event, the required trunk line would be run to the North Star pump station as shown in Figure 4G-1. The trunk line would access potential groundwater disposal areas located in the northwest portion of the sub-region or would connect to a larger regional system. (Larger regional concepts are discussed elsewhere in this report)

Treatment & Disposal Areas

A composite GIS map of disposal constraints was shown in Figure 4B-2. Areas that meet the minimum depth to groundwater and hydraulic conductivity criteria are shown on the map in purple. In addition to meeting these criteria, the distance between any disposal site and down gradient surface waters or public water supply wells, should be maximized to reduce potential impacts. Existing subdivisions, neighborhoods, and commercial areas should also be avoided where possible. An aerial map showing landforms and structures was shown in Figure 4B-3. This figure can be used to refine possible disposal site locations by considering the location of physical interferences.

The treatment and disposal facilities serving this sub-region require a minimum of from 19 to 28 acres of suitable land. The lower amount reflects a facility serving growth of 5000 equivalents in currently un-served areas. The larger amount includes all sub-regional flows. An inspection of constraint and aerial photo drawings suggests that suitable disposal areas may be located north of Galactic Park and west of Jackrabbit Lane. Although other areas may exist on either side of Jackrabbit, much of this land may involve high value road frontage and may not be affordable.

Water Rights

According to the previously presented discussion on water rights, the transport of effluent may be prevented by mitigation requirements of certain water rights established after 2003. Given the proximity of the proposed disposal area to the service area, encountering water rights complications appears to be unlikely for this alternative. Although this alternative appears to benefit from a favorable water rights situation, further analysis is necessary to establish what mitigation requirements would apply to the drinking water supply to future customers. That evaluation is beyond the scope of this project.

Facility Summary

Flow Rate:	500,000 to 730,000 Gallons/Day
Treatment Level:	Group 5 Nitrogen Removal
Disposal:	Groundwater Discharge
Land Required:	19 to 28 Acres
Permit:	Montana groundwater pollution control permit
Water Quality:	Groundwater discharge mixing zone cannot intersect surface water

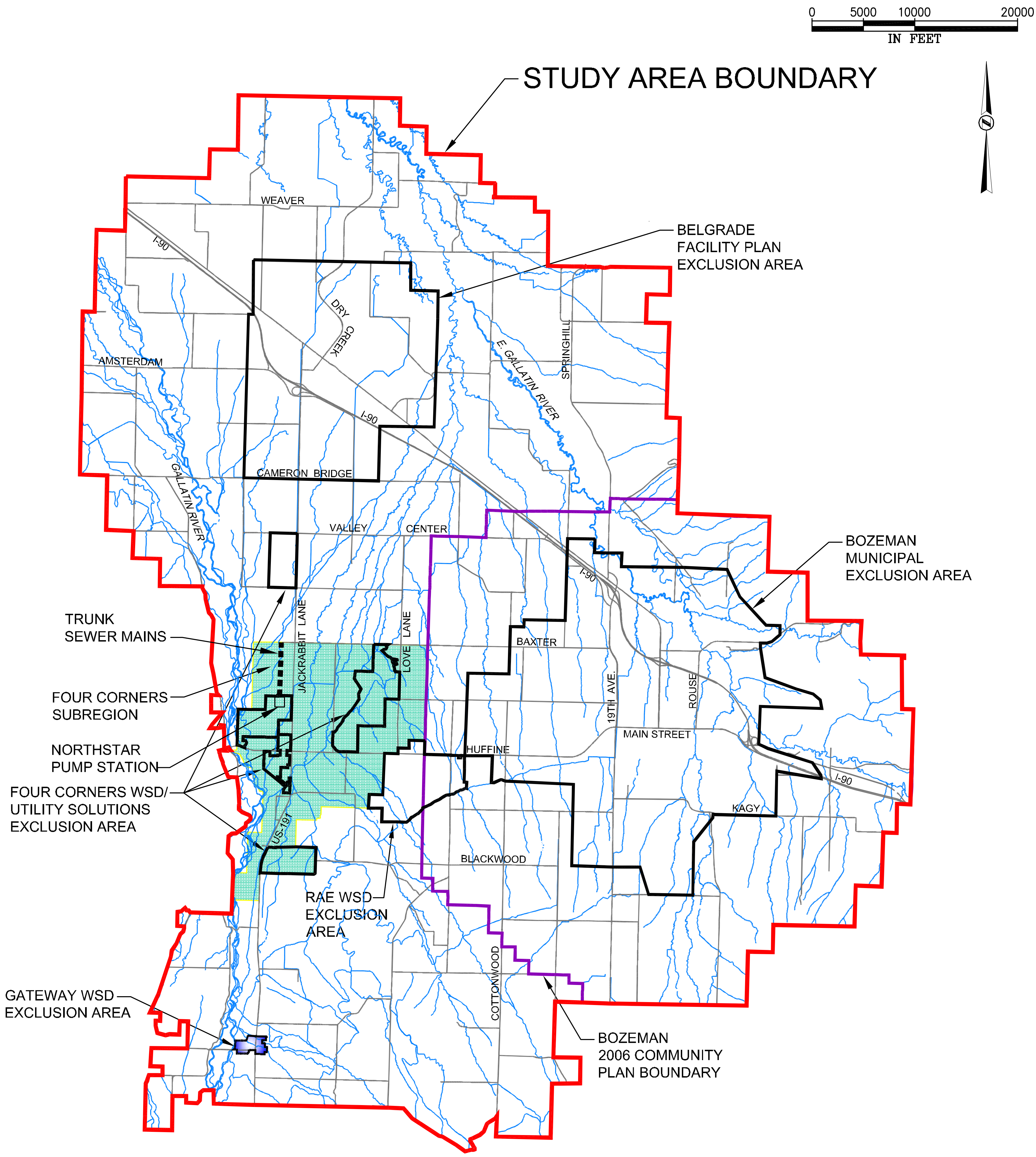

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FIG. 4G-1

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PART 5
SCREENING OF ALTERNATIVES
7, 8, 9

SECTION A
INTRODUCTION & SUMMARY

1. INTRODUCTION

Part 5 conceptually evaluates collection, treatment, and disposal systems for larger portions of the study area. Each of these alternatives is briefly described below:

- Alternative 7 considers a system serving the entire study area; in this alternative, average study area densities are assumed and then used to determine the overall system economics.
- Alternative 8 explores the possibility of treated effluent hydropower generation with disposal in the Missouri River near Trident, Montana.
- Alternative 9 is identical in scope to Alternative 8 except that the Missouri River discharge option is replaced with a groundwater disposal system located northwest of Belgrade, Montana.

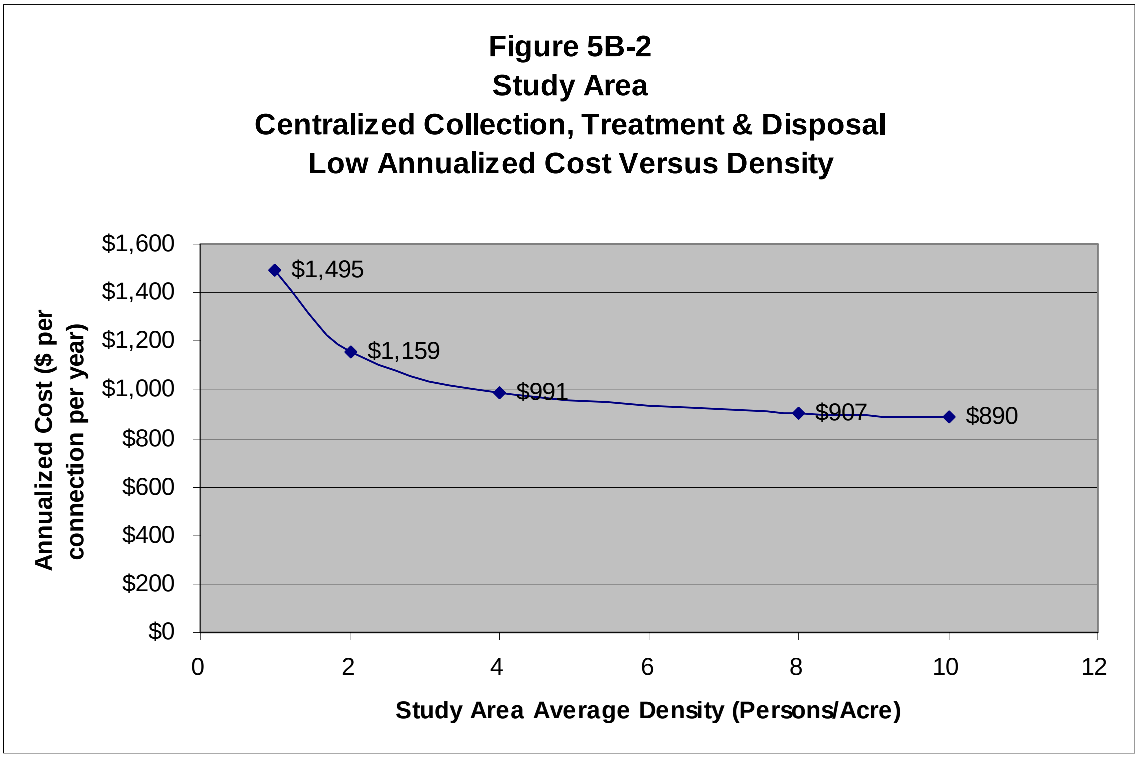
A summary of centralized collection and treatment costs for all of the alternatives is presented below.

2. SUMMARY

As with previous alternatives, the previously presented zoning and population evaluations and cost calculation spreadsheets were used to generate estimates of collection, treatment, and disposal costs for each alternative. Where appropriate, cost sensitivity analysis were also performed. For alternative 7, a slightly different procedure was used in that the population and average study area density was varied to explore the effect on the project economics. In Alternative 8, the cost of a Missouri River pipeline was substituted for the cost of a groundwater disposal system. The specific spreadsheet input criteria and analysis approach are described in the write-up for each alternative.

Alternative 7

The results of Alternative 7 are best described by a plot of annualized cost versus average study area density. As shown in Figure 5A-1 below, the line slope begins to flatten at a density of around 4 persons per acre. This inflection point does not represent the point of "affordability," rather; it represents a point where the user base is sufficient to overcome the sunk cost of collection system serving a 95,000 acre service area. An average density of 4 is equivalent to a population of almost 400,000 persons, which, given the zoning maximum of 2.8 (265,000 persons), appears unlikely to ever be achieved. This analysis assumed a uniform density across the study area. This assumption, while necessary for performing the work, is not envisioned in the current planning and zoning slate and is likely unrealistic.



<u>Alternative 8</u>

In Alternative 8, a pressure pipeline is used to connect a treatment facility located northwest of Belgrade to a hydropower generation and effluent discharge facility located near Trident, Montana. This alternative has a variety of technical problems that most importantly include non-degradation significance trigger levels that are difficult and expensive to meet and that limit the amount of flow to the facility. Unfortunately, the power generation potential of this idea is miniscule when compared to the overall project costs. Lastly, the analysis shows that the cost of a pipeline to Trident, at approximately 22 miles, is significantly more than the cost of groundwater disposal facility near Belgrade.

<u>Alternative 9</u>

This alternative is a re-hash of Alternative 8 except that a groundwater disposal system is used to replace the pipeline to Trident. Using previously established methods, the annualized cost range for this alternative is about $1200 to $1700 per connection per year depending on which assumptions are used.

Starting in Section B below, each alternative is evaluated in more detail including a description, a population and flow summary, maps, economics, and a brief discussion of the general facility requirements and considerations.

SECTION B
SCREENING OF ALTERNATIVE NO.7
STUDY AREA CENTRAL COLLECTION AND TREATMENT

1. DESCRIPTION AND LOCATION

This section evaluates collection, treatment, and disposal for the entire study area as defined by the wastewater subcommittee. The study area can be generally described as a region of the Gallatin Valley extending from Bozeman to Belgrade and south to Gallatin Gateway. There are approximately 121,500 acres within the study area boundary less 27,000 acres that are excluded giving a net study area size of about 94,500 acres. The excluded areas are within the:

- Bozeman municipal boundary and areas surrounded or nearly enclosed by the Bozeman municipal boundary,
- Belgrade water plan boundary,
- Rae County Water and Sewer District,
- Gallatin Gateway Water and Sewer District, and
- Four Corners Water and Sewer District and areas outside of the District that are being served by Utility Solutions.

Note: The term "Study Area" refers to the area within the study area boundary less the excluded areas listed above.

2. POPULATION SUMMARY

The purpose of this analysis is to determine the overall, or uniform, study area density that is required to produce cost effective centralized wastewater collection, treatment, and disposal for the entire study area. In this case, all study area lands are assumed to have the same density. A series of assumed populations are then modeled to determine the cost estimate for combined collection, treatment, and disposal costs at each corresponding population and density. The density and corresponding populations for the study area are presented in Table 5B-1 below. As shown, the existing average density is estimated at 0.23 persons per acre. The higher density and population numbers are assumed values used solely for the purposes for evaluating the how the cost effectiveness of centralized facilities varies with density and <u>are not population projections.</u> At the present time, the study area is zoned for approximately 265,000 persons corresponding to an average study area density of 2.8 persons per acre.

Table 5B-1
Study Area Average Density & Population

Average Density	Population	Comment
0.23	Approx. 22,000	Current Study Area
1	95,000	
2.8	265,000	Study Area Zoning Value
4	380,000	
8	760,000	

3. ESTIMATED ANNUALIZED COST

Basic Analysis

The previously presented spreadsheets were used to generate estimates of collection, treatment, and disposal costs for the study area for several assumed population estimates. The starting model inputs are the same as used for other alternatives analysis and are provided below. Figure 5B-1 presents the resulting annual costs as a function of the required study area density. As shown, the cost range is $3000 per connection per year at a density of 1 person per acre dropping to about $1270 per connection per year at a density of 10 persons per acre. Considering that a study area density much above 4 is probably not realistic, economical service appears unattainable for the given set of conditions.

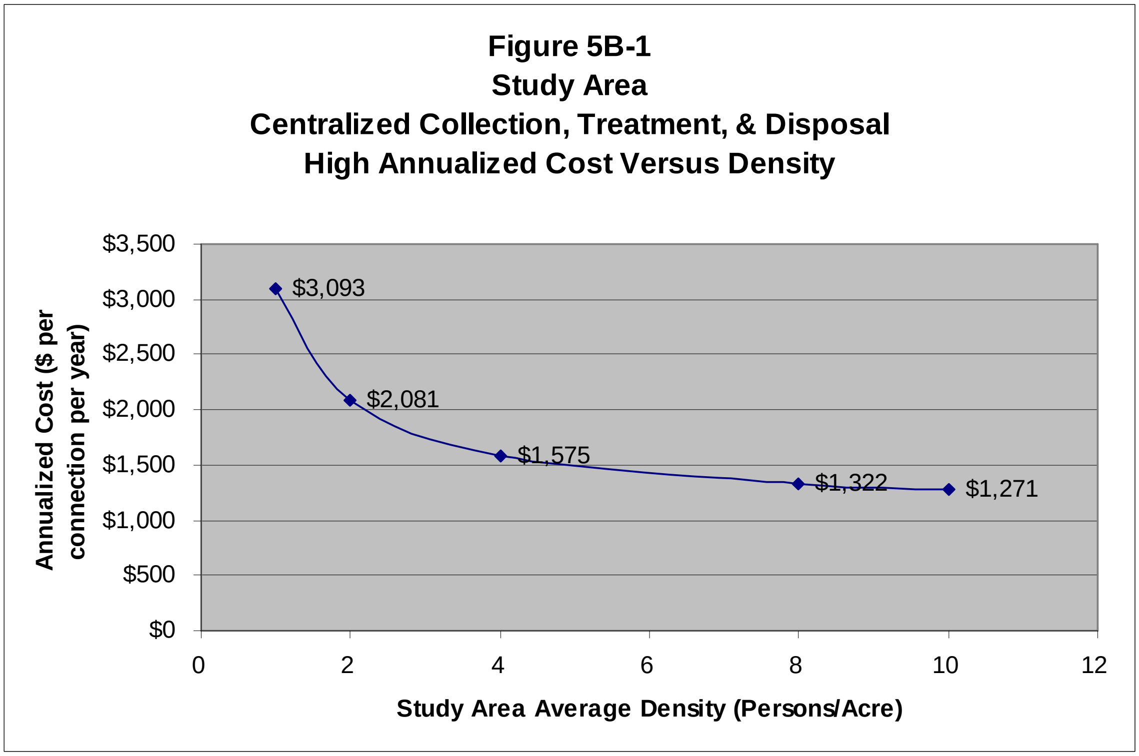


Table 5B-2 Alternative 7 Input Data for Basic Analysis	
Treatment System Construction Cost ($/Gal-Day of Capacity)	$28
Treatment System O&M Cost (Percent)	5
Collection System O&M Cost ($ Annum/Mile)	$3,600
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	1.00
Disposal System Construction Cost ($/Acre)	$350,000
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	100.0

<u>Sensitivity Analysis</u>
As shown in Table 5B-3, the collection system public financing percentage was changed to 30 percent to provide a more realistic share of publically financed sewer infrastructure. Using a figure of 30 percent means that 70 percent of the sewer infrastructure cost is allocated to future private development projects. In addition, the treatment system construction cost was lowered to $22 per gallon of capacity to reflect the expected scale efficiencies available for a very large system. For these same reasons, the treatment system operation and maintenance cost was lowered to 4 percent from 5 percent.

Figure 5B-2 below presents the resulting costs as a function of study area density. The changes in assumptions produce substantially lower numbers than in the previous example. As shown, the unit cost range ranges from $1500 per connection per year at a density of 1 to about $890 per connection per year at a density of 10. At densities above 1, the estimated costs are substantially less than previously estimated costs for decentralized (Group 1 & 2) systems. If the study area were to achieve its zoned population of 265,000 persons, annualized costs in this case would be around $1000 per connection per year.

Note:	The Study Area contains at least 47 planning and/or zoning designations and is not zoned uniformly as was assumed for this analysis.

Figure 5B-2
Study Area
Centralized Collection, Treatment & Disposal
Low Annualized Cost Versus Density

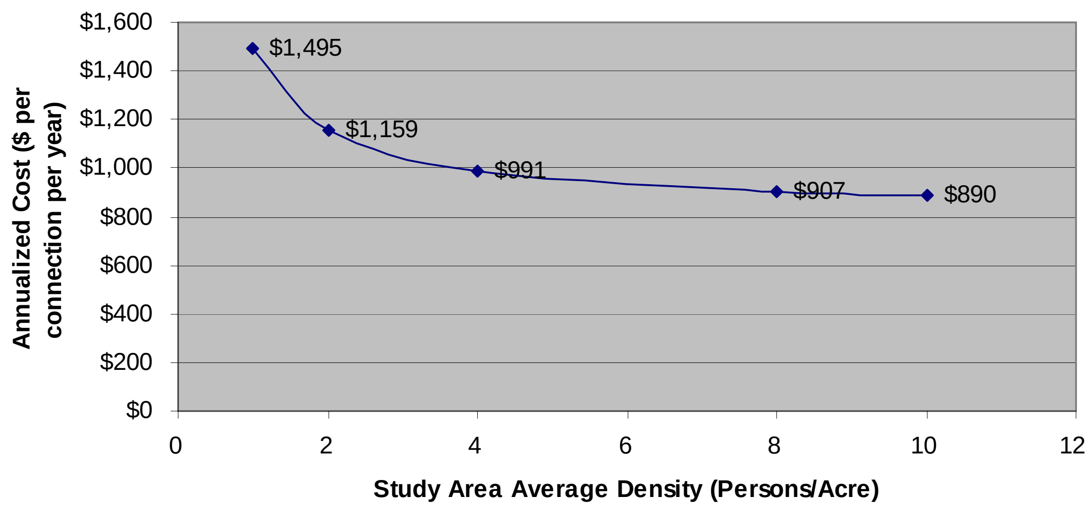


Table 5B-3 Alternative 7 Input Data for Sensitivity Analysis	
Treatment System Construction Cost ($/Gal-Day of Capacity)	$22
Treatment System O&M Cost (Percent)	4
Collection System O&M Cost ($ Annum/Mile)	$3,600
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	1.00
Disposal System Construction Cost ($/Acre)	$350,000
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	30.0

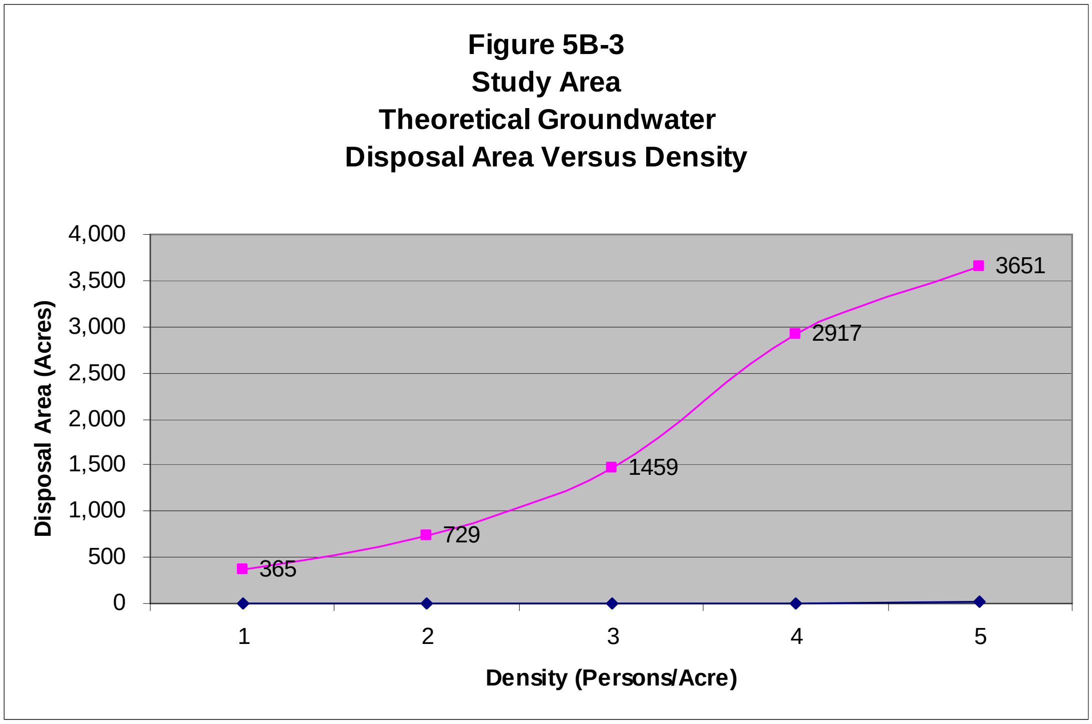
4. GENERAL FACILITY REQUIREMENTS & CONSIDERATIONS

Centralized facilities serving the entire study area would encounter many constraints and technical problems. This should be no surprise considering that the contemplated service area of 94,500 acres is about 7 times greater than the Bozeman municipal boundary area. The following sections identify and briefly discuss some of the major constraints associated with the implementation of this concept.

<u>Wastewater Disposal Area</u>

As shown in Figure 5B-3 above, the land requirements for subsurface disposal are large. For example a groundwater infiltration disposal site capable of serving the study area at its zoning maximum of 2.8 persons per acre would require approximately 1250 acres or 2 sections. Referring to the study area constraints and aerial maps, Figures 5B-4 and 5B-5, indicates that large parcels of suitable land with a minimum of constraints are not readily available except possibly in and around the Belgrade facility planning area. Although the maps suggest that suitable lands exist in those locations, acquiring such an amount would require negotiations with multiple owners as well as local government entities.

Note: The scope of work for this project requires groundwater disposal be used. If a reclaimed quality effluent were produced, effluent disposal may have fewer disposal constraints, such as water rights, and costs. Producing a reclaim quality effluent involves additional treatment processes beyond those described in this report for Group 6 facilities.



Conveyance

Given that a system serving the entire study area is unlikely, a sewer trunk line map was not prepared for this alternative. With the largest least constrained disposal located near the north and west edges of the Belgrade facility planning area, the collection system would be designed for connection to that general location. Although the overall study area topography promotes gravity flow from south to north; several pump stations would be necessary for moving wastewater from the northeast study area, the far northwest study area, and the far north central study area to the treatment and disposal area. In reality, a series of smaller pump stations is more likely than 3 large pump stations meaning that at least 3 to 6 facilities would be required over time. In addition to the pump stations, multiple road and stream crossings would also be required.

Water Rights

According to the previously presented discussion on water rights, the transport of effluent may be prevented by mitigation requirements of certain water rights most notably those established after 2003. Given the transport distances involved, the mitigation requirements of all water rights must be carefully considered before planning a study area wide system. That evaluation is beyond the scope of this project.

Water Quality Issues

A Montana groundwater pollution control permit would be required. Even though the proposed disposal is to the groundwater, the ultimate destination for such large effluent volumes is very likely to be down-gradient surface water. Although the disposal system engineering process would attempt to minimize these impacts, it's likely that surface water impacts could be identified. The end result of this situation could be a requirement for Group 6 level treatment and/or a reduction in allowable discharge volumes.

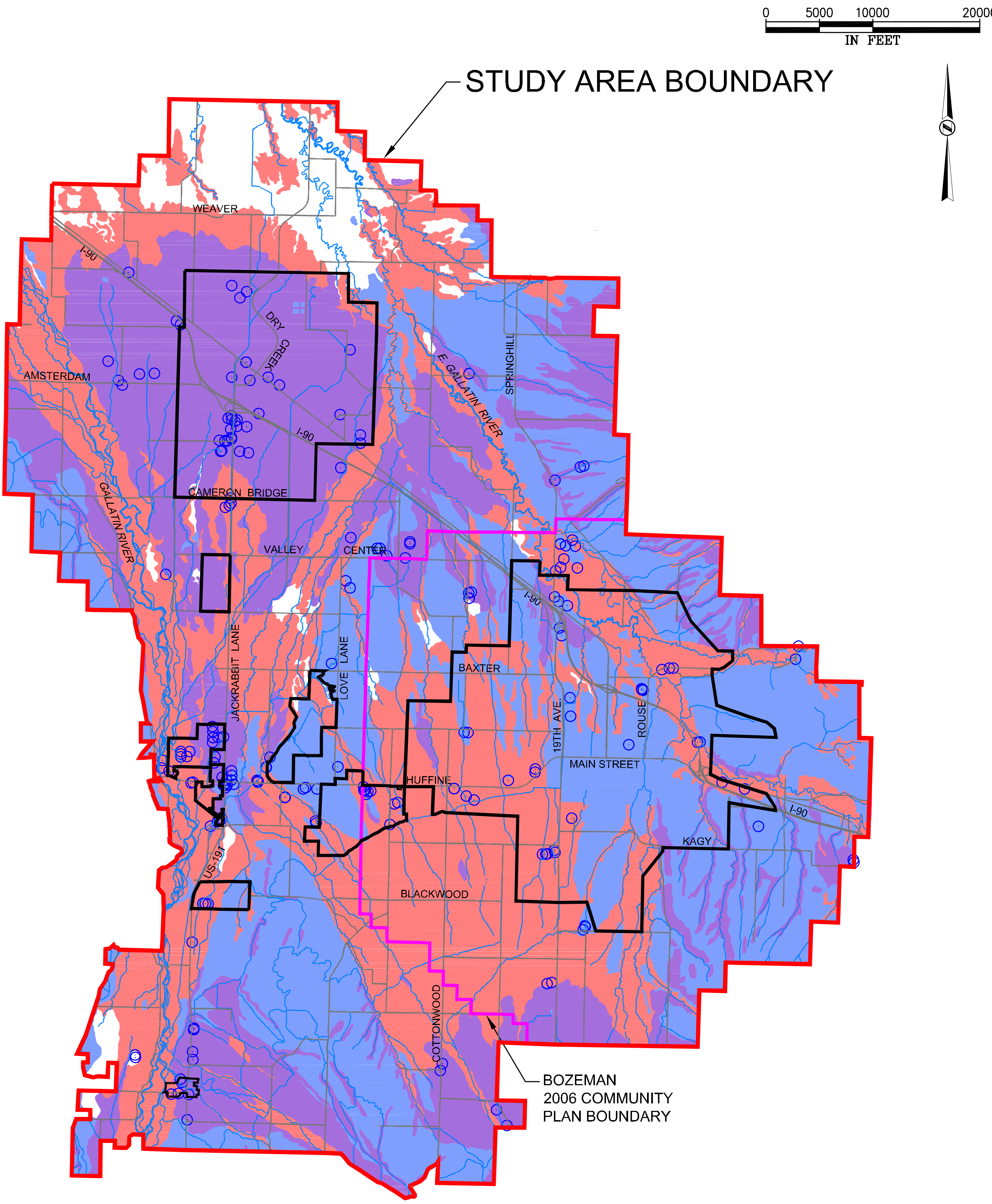
Facility Summary

A summary of the possible facility characteristics as a function of study area density is presented in Table 5B-4 below.

Table 5B-4
Facility Summaries

Parameter	Ave. Density=1	Ave. Density=2.8	Ave. Density=4
Flowrate (MGD)	9.5	26.5	38
Treatment Level	Group 5 or 6	Group 5 or 6	Group 5 or 6
Disposal Area (Acres)	365	1,300	2,900
Surface Water Impacts	Possible	Possible	Highly Likely
Water Rights Restrictions	Possible	Possible	Possible
Cost ($ per Connection/Year)	$1,500 to $3,100	$1,060 to $1,790	$990 to $1,575

N:\0939-01809 GALLATIN COUNTY WW STUDY PH2\dwg\Figures\Fig -5B-4 Study Area Disposal Constraints.dwg, FIG-5B-4 DISPOSAL, Plotted: Sep 15, 2010 - 2:35pm, brickert



KEY

- AREAS WITH >6' TO GROUNDWATER
- AREA WITH FAVORABLE HYDRAULIC CONDUCTIVITY
- AREAS WITH BOTH >6' TO GROUNDWATER AND FAVORABLE HYDRAULIC CONDUCTIVITY
- AREAS WITH BOTH <6' TO GROUNDWATER AND UNFAVORABLE HYDRAULIC CONDUCTIVITY
- PUBLIC WELL WITH 500' RADIUS

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2. SOIL DATA IS FROM NRCS SURGO DATA AND NASIS DATABASE.
3. WELL DATA IS FROM GALLATIN COUNTY LOCAL WATER QUALITY DISTRICT.

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STUDY AREA DISPOSAL CONSTRAINTS

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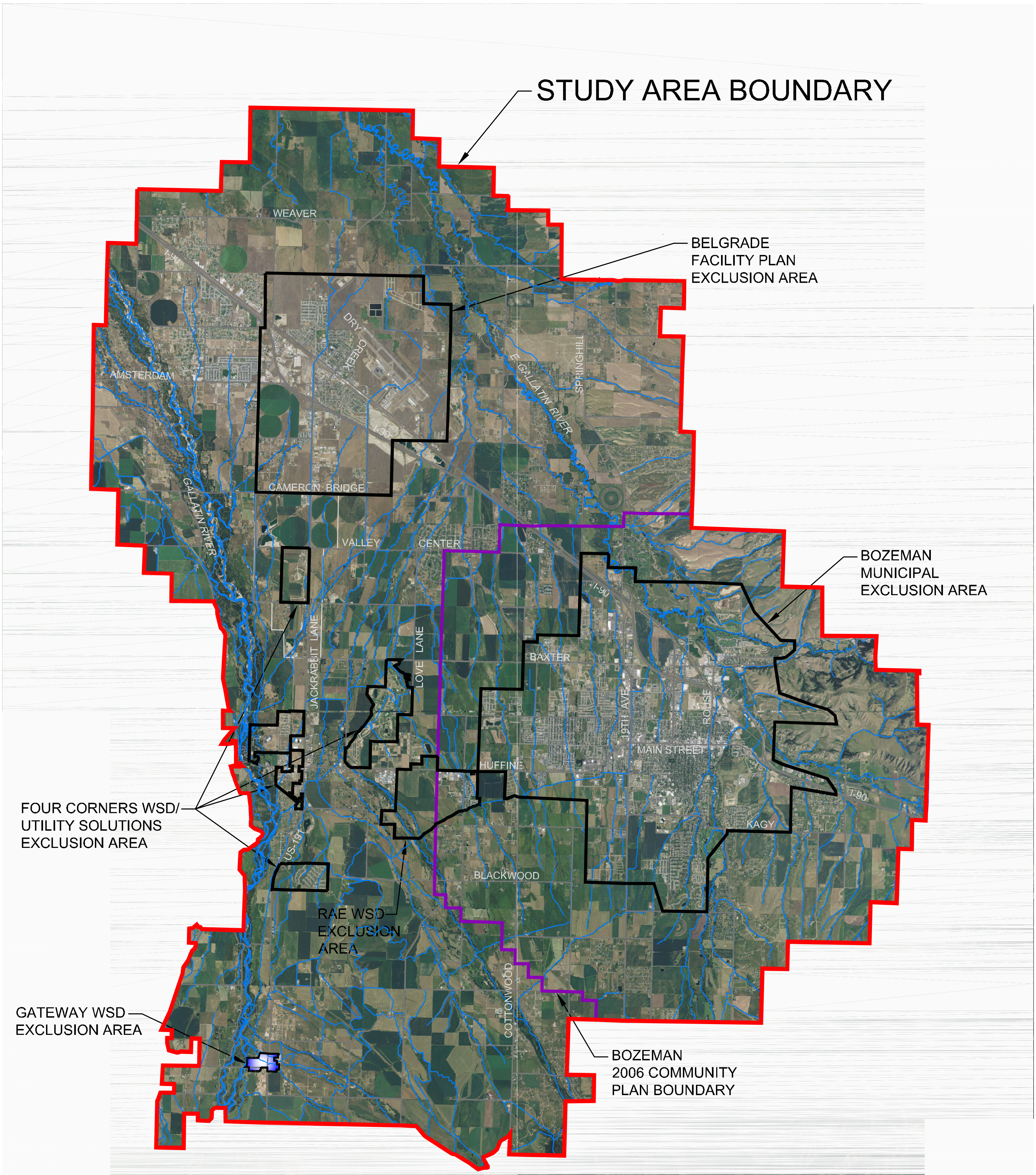

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FIG. 5B-5

STUDY AREA AERIAL

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SECTION C
SCREENING OF ALTERNATIVE NO.8
STUDY AREA CENTRAL COLLECTION & TREATMENT AND COMBINED HYDROPOWER GENERATION WITH MISSOURI RIVER DISCHARGE

1. DESCRIPTION AND LOCATION

Hydropower generation is a concept of interest to the public and was therefore included in the scope of work for this project. In this alternative, treated effluent would be conveyed from the Belgrade area in a pressure line to the Trident area for hydropower generation with disposal in the Missouri River.

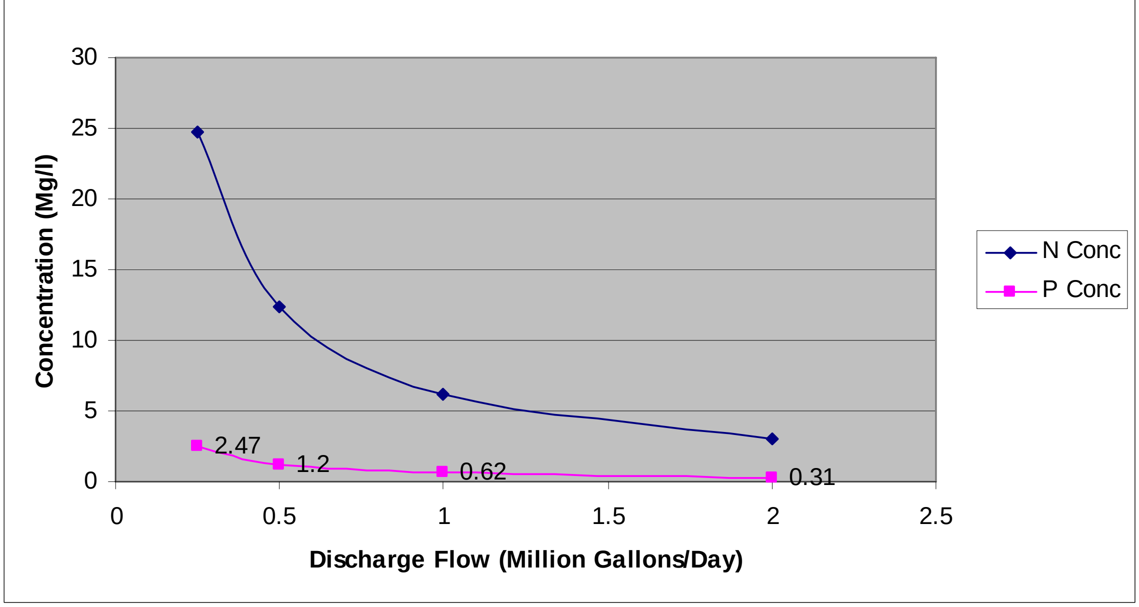
Belgrade, elevation 4350, is approximately 320 feet higher than the proposed discharge location at Trident located approximately 22 miles to the west. The advantage of this concept over concepts proposed by the Phase 1 study is that the pressure line exists downstream of all sewer system users and the treatment facility. This eliminates the need for lower elevation customers to have a pressurized sewage pumping station.

Piping treated effluent to the Missouri River would eliminate the need for a groundwater disposal system. As a result, the economics of this alternative depend in part on the cost differential between the disposal system and costs to build the pipeline and the power generation facilities. In the event that hydropower generation is not practical, a Missouri River discharge may be of interest as a stand alone alternative in the event that groundwater disposal within the study area is not available.

2. POPULATION SUMMARY

The population served by this alternative may limited by Missouri River water quality considerations such as the non-degradation significance trigger limits. Figure 5C-1 below is an estimate of the allowable phosphorous and nitrogen discharge concentrations as a function of flow. At approximately 2 million gallons per day, the required effluent nitrogen and phosphorous concentrations (3 mg/l and 0.3 mg/l) reach the limit of currently available technology and cannot be reduced further. Assuming a unit wastewater generation rate of 100 gallons per person per day, this flow rate is equivalent to a service population of around 20,000 persons.

2,000,000 Gallons per day / 100 Gallons per person per day	=20,000 Equivalent Population Served



3. ESTIMATED ANNUALIZED COST

Basic Analysis

The previously presented spreadsheet tools were used to generate estimates of collection, treatment, and disposal costs for this alternative. Using previously presented sub-region population estimates, a year 2030 population of 20,000 persons would include the West Belgrade, Jackrabbit, Valley Center, and Northwest Bozeman sub-regions. The spreadsheet model inputs are provided below in Table 5C-1. (These starting parameters are the same used for the initial analysis of the other alternatives

Because this alternative contemplates a Missouri River discharge, the groundwater disposal system cost is replaced by the cost of a pipeline linking the treatment facility to the disposal point in Trident. With an assumed treatment plant location of northwest of Belgrade, the approximate pipeline length is 22 miles. The estimated cost of a Missouri River pipeline is compared to the groundwater disposal system cost for a variety of flow rates in Figure 5C-2 below. As shown, the pipeline cost significantly exceeds the disposal system cost in all cases. In addition, unlike neighborhood sewers that will have some percentage that is privately financed, this pipeline must be financed entirely with public funds.

For the given set of inputs, the estimated annual cost for this alternative is about $1630 per connection per year not including the capital and operating costs of the hydropower infrastructure. Given the high projected cost structure, there was not a valid reason to prepare cost estimates for hydropower facilities.

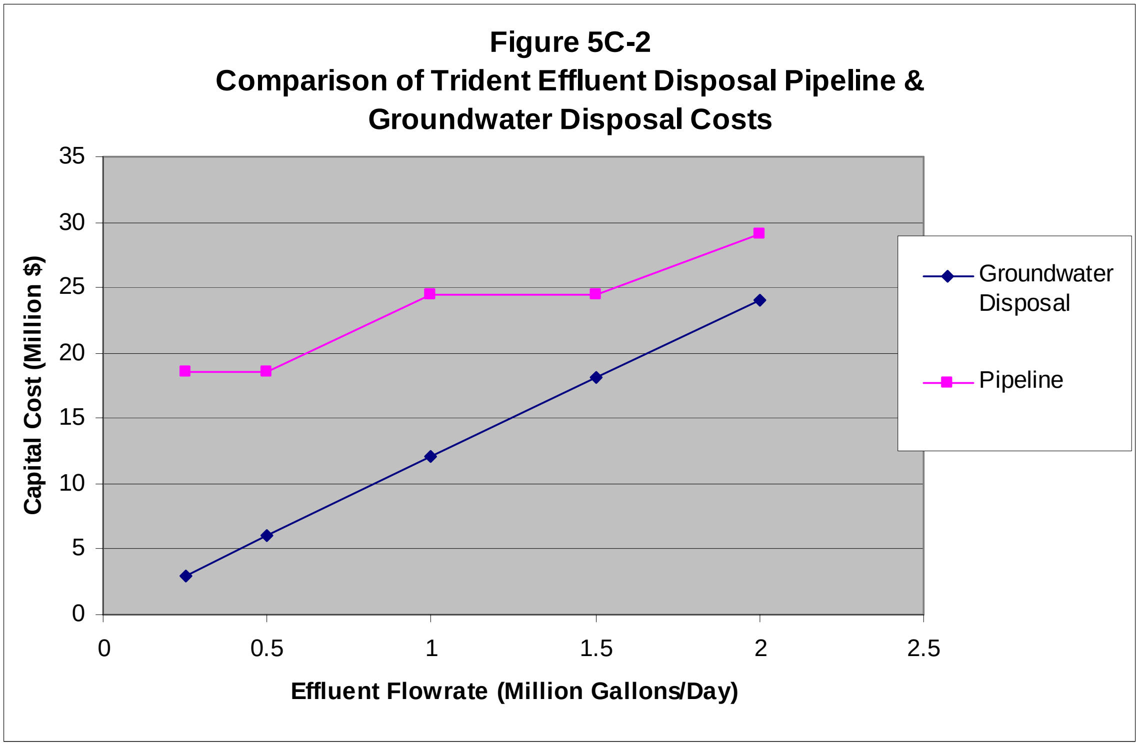


Table 5C-1 Alternative 8 Input Data for Basic Analysis	
Treatment System Construction Cost ($/Gal-Day of Capacity)	$28
Treatment System O&M Cost (Percent)	5
Collection System O&M Cost ($ Annum/Mile)	$3,600
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	Pipeline to Missouri
Disposal System Construction Cost ($/Acre)	Pipeline to Missouri
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	100.0

Sensitivity Analysis

As shown in Table 5C-2, the collection system public financing percentage was changed to 30 percent to provide a more realistic share of publically financed sewer infrastructure. Using a figure of 30 percent means that 70 percent of the sewer infrastructure cost is allocated to future private development projects. Unlike other alternatives, the treatment system construction cost was maintained at $28 per gallon of capacity to reflect the expected high treatment level necessary for a Missouri River Discharge. For these same reasons, the treatment system operation and maintenance cost was kept at 5 percent.

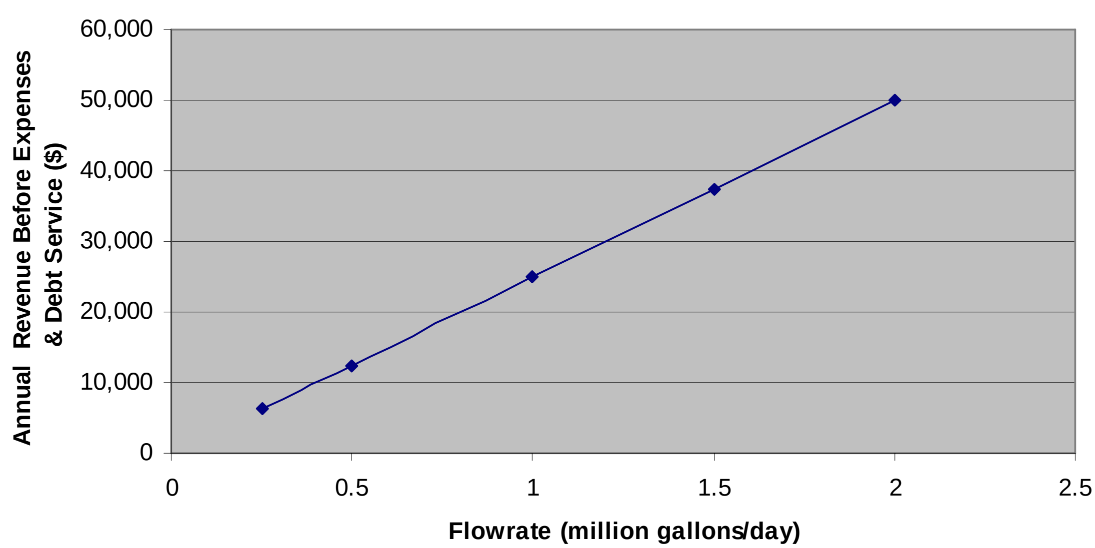
For the given set of inputs, the estimated annual cost drops slightly to $1280 per connection per year not including the capital and operating costs of the hydropower infrastructure. If the value of the power generated (See Figure 5C-3 below) is credited to the project, there is no material change in the annual unit costs because the power value is less than a half percent of annual debt service and operational costs.

Based on this analysis, the hydropower generating concept is not economically feasible because of projected low revenue relative to overall project costs and on the fact that the Missouri River pipeline is significantly more expensive than a groundwater disposal system located near Belgrade. In the event that groundwater disposal areas cannot be obtained, a pipeline to the Missouri may represent an alternative, but more expensive, disposal method.

Table 5C-2
Alternative 8
Input Data for Sensitivity Analysis

Treatment System Construction Cost ($/Gal-Day of Capacity)	$28
Treatment System O&M Cost (Percent)	5
Collection System O&M Cost ($ Annum/Mile)	$3,600
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	Pipeline to Missouri
Disposal System Construction Cost ($/Acre)	Pipeline to Missouri
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	30.0

Figure 5C-3
Theoretical Hydropower Revenue
(8 Cents/KWH Basis)



4. GENERAL FACILITY REQUIREMENTS & CONSIDERATIONS

Sewer Trunk Line

The approximate location of the required main trunk sewers is shown in Figure 5C-4. As shown, this alternative requires that several sub-regions be connected to a regional collection system feeding a treatment facility located north northwest of Belgrade facility Plan boundary. The trunk lines shown are simply the combination of the sub-regional trunk lines previously presented in Alternatives 1-6 in Part 4 of this report.

Missouri River Pipeline

Because of high costs, the routing of a Missouri River pipeline was not evaluated in much detail and a pipeline routing diagram was not prepared. For the purposes of this evaluation, we assumed that the line would parallel existing Route 205 on private land where possible. In addition to passing through the Town of Manhattan, a major crossing of the West Gallatin would also be required. Numerous other minor road and ditch crossings would also be needed.

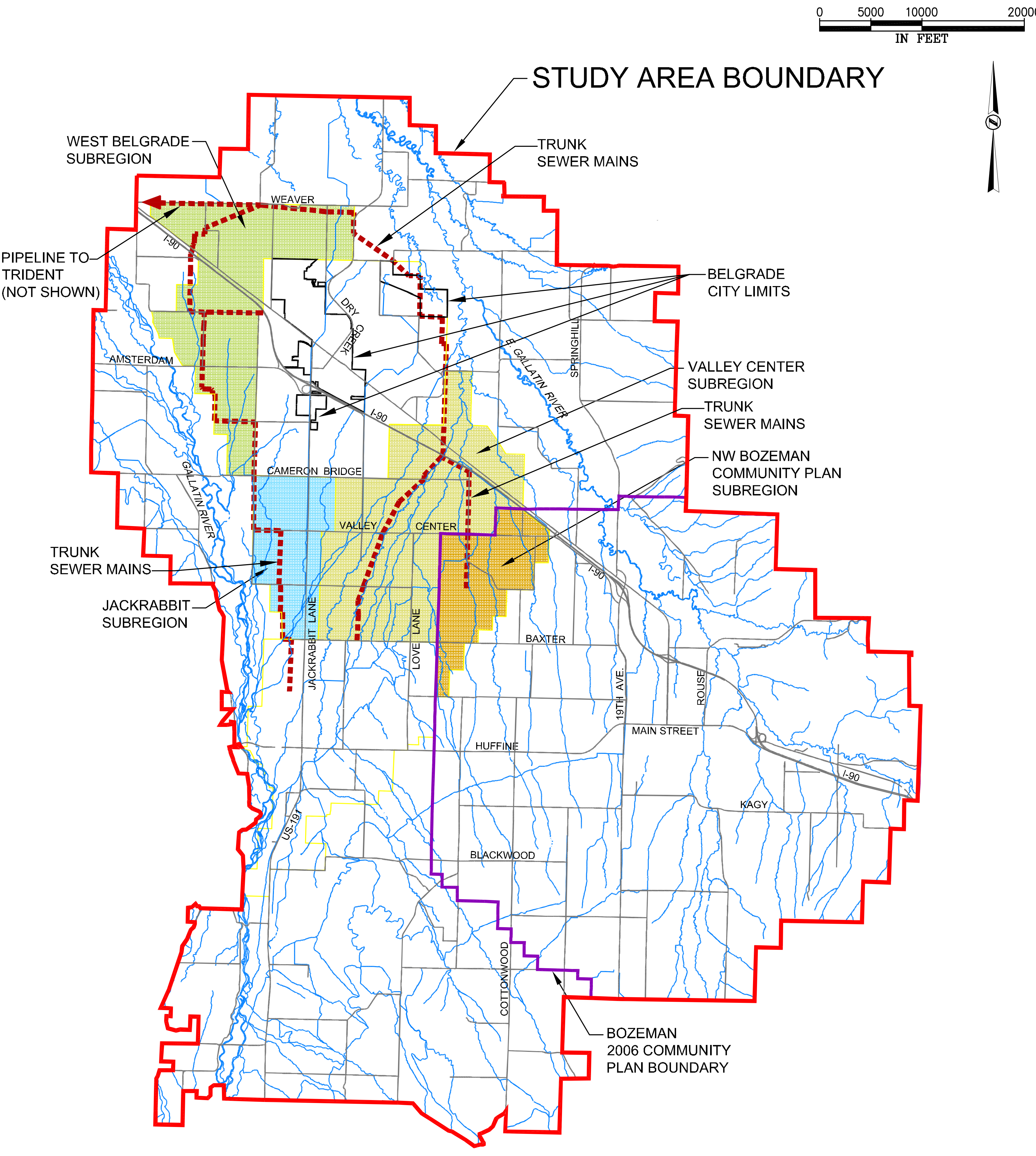
Water Rights

According to the previously presented discussion on water rights, the transport of effluent to the Missouri may be prevented by mitigation requirements of certain water rights established after 2003. The existing service area population is approximately 3700 persons which equates to 370,000 gallons per day. This effluent volume can likely be conveyed to the Missouri for disposal without complication. The ability to transport and dispose of the additional remaining effluent would depend on the age and conditions of the water rights used to supply drinking water to those additional customers. That evaluation is beyond the scope of this evaluation.

Facility Summary

For this alternative, the logical location for a treatment facility is located just north and northwest of the Belgrade Facility Plan Boundary. Additional facility criteria are given below:

Flow Rate:	2,000,000 Gallons per day
Treatment Level:	Group 6 Nitrogen & Phosphorus Removal
Disposal:	Missouri River Discharge
Land Required:	Approximately 4 acres for the treatment facility
Permit:	MPDES surface water discharge permit for Missouri River



NOTES:

1. GIS DATA SUPPLIED BY GALLATIN COUNTY GIS DEPARTMENT VIA GALLATIN COUNTY PLANNING DEPARTMENT. SHOWN IN MONTANA STATE PLANE (FEET).

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FIG. 5C-4

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ALTERNATE No. 8 TRUNK SEWERS

REGIONAL WASTEWATER TREATMENT FEASIBILITY STUDY, PHASE 2
GALLATIN COUNTY, MONTANA

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SECTION D
SCREENING OF ALTERNATIVE NO. 9
CENTRAL COLLECTION & TREATMENT FOR THE COMBINED SUBREGIONS OF WEST BELGRADE, JACKRABBIT, VALLEY CENTER, and NORTHWEST BOZEMAN

1. DESCRIPTION AND LOCATION

This alternative is identical to the preceding Alternative 8 except that a groundwater disposal system is used instead of a Missouri River pipeline. In the interest of brevity, the reader is referred to the discussion of Alternative 8 for more information. The following sections discuss the differences that result from using a groundwater discharge system as the disposal method.

2. POPULATION SUMMARY

This alternative serves the West Belgrade, Valley Center, Jackrabbit, and Northwest Bozeman sub-regions. This service area will have a combined population of about 20,000 persons in 2030.

3. ESTIMATED ANNUALIZED COST

Basic Analysis

The spreadsheet model inputs are provided below in Table 5D-1. For the given set of inputs, the estimated annual cost for this alternative is about $1750 per connection per year.

Table 5D-1 Alternative 9 Input Data for Basic Analysis	
Treatment System Construction Cost ($/Gal-Day of Capacity)	$28
Treatment System O&M Cost (Percent)	5
Collection System O&M Cost ($ Annum/Mile)	$3,600
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	1.0
Disposal System Construction Cost ($/Acre)	350,000
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	100.0

Sensitivity Analysis

As shown in Table 5D-2, the collection system public financing percentage was changed to 30 percent to provide a more realistic share of publically financed sewer infrastructure. Using a figure of 30 percent means that 70 percent of the sewer infrastructure cost is allocated to future private development projects. The treatment system construction cost was lowered to $22 per gallon of capacity to reflect the more likely need for a Group 5 nitrogen removal plant rather than a combined nitrogen and phosphorous removal plant. For the given set of inputs, the estimated annual cost drops to about $1,230 per connection per year.

Table 5D-2 Alternative 9 Input Data for Sensitivity Analysis	
Treatment System Construction Cost ($/Gal-Day of Capacity)	$22
Treatment System O&M Cost (Percent)	5
Collection System O&M Cost ($ Annum/Mile)	$3,600
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	350,000
Disposal System Construction Cost ($/Acre)	$10,000
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	30.0

4. GENERAL FACILITY REQUIREMENTS & CONSIDERATIONS

Sewer Trunk Line

The approximate location of the required main trunk sewers was shown previously in Figure 5C-4. As shown, this alternative requires that several sub-regions be connected to a regional collection system feeding a treatment facility located north northwest of Belgrade facility plan boundary.

Treatment & Disposal Areas

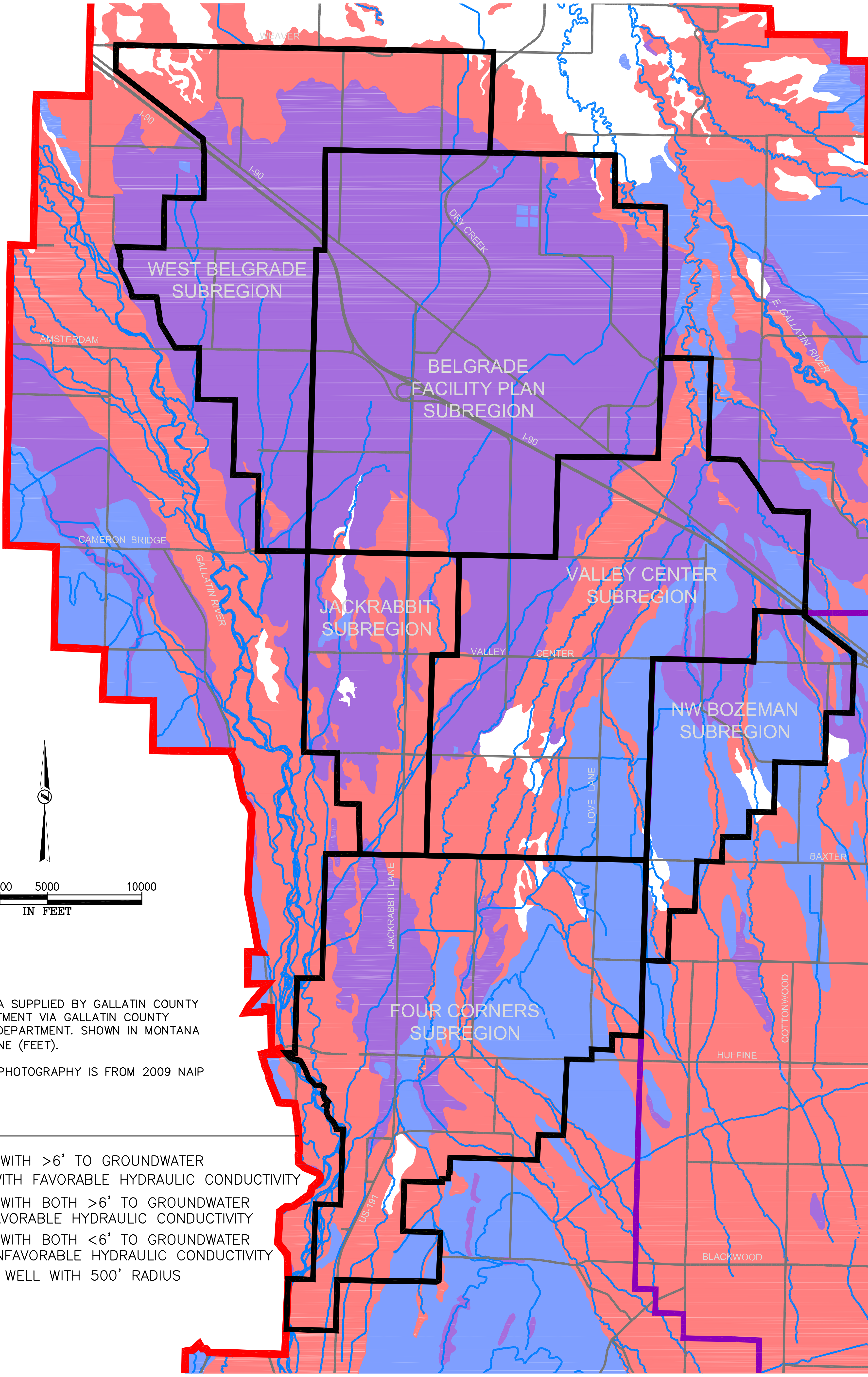
This alternative requires approximately 75 acres of land for the wastewater treatment plant and the groundwater disposal facility. Referring to the constraints and aerial photography maps 4B-2 and 4B-3, (copies are provided on the next page) the most favorable sites have the greatest depth to groundwater and highest hydraulic conductivity. These areas are shown on the map in purple. In addition to meeting these criteria, the distance between any disposal site and down gradient surface waters or public water supply wells, should be maximized to reduce potential impacts. Existing subdivisions, neighborhoods, and commercial areas should also be avoided where possible. A review of the maps suggests that areas located within the far north portions of the West Belgrade sub-region just south and parallel to Weaver Road may be best for the treatment and disposal facilities.

Water Rights

According to the previously presented discussion on water rights, the transport of effluent to the Missouri may be prevented by mitigation requirements of certain water rights established after 2003. The existing service area population is approximately 3700 persons which equates to 370,000 gallons per day. This effluent volume can likely be conveyed to the Missouri for disposal without complication. The ability to transport and dispose of the additional remaining effluent would depend on the age and conditions of the water rights used to supply drinking water to those additional customers. That evaluation is beyond the scope of this evaluation.

Facility Summary

Flow Rate:	2,000,000 Gallons/Day
Treatment Level:	Group 5 Nitrogen Removal
Disposal:	Groundwater Discharge
Land Required:	75 Acres
Permit:	Montana groundwater pollution control permit
Water Quality:	Groundwater discharge mixing zone cannot intersect surface water



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2. AERIAL PHOTOGRAPHY IS FROM 2009 NAIP IMAGERY.

KEY

- AREAS WITH >6' TO GROUNDWATER
- AREA WITH FAVORABLE HYDRAULIC CONDUCTIVITY
- AREAS WITH BOTH >6' TO GROUNDWATER AND FAVORABLE HYDRAULIC CONDUCTIVITY
- AREAS WITH BOTH <6' TO GROUNDWATER AND UNFAVORABLE HYDRAULIC CONDUCTIVITY
- PUBLIC WELL WITH 500' RADIUS

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FIG. 4B-2

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SUBREGIONS DISPOSAL CONSTRAINTS - ENLARGED

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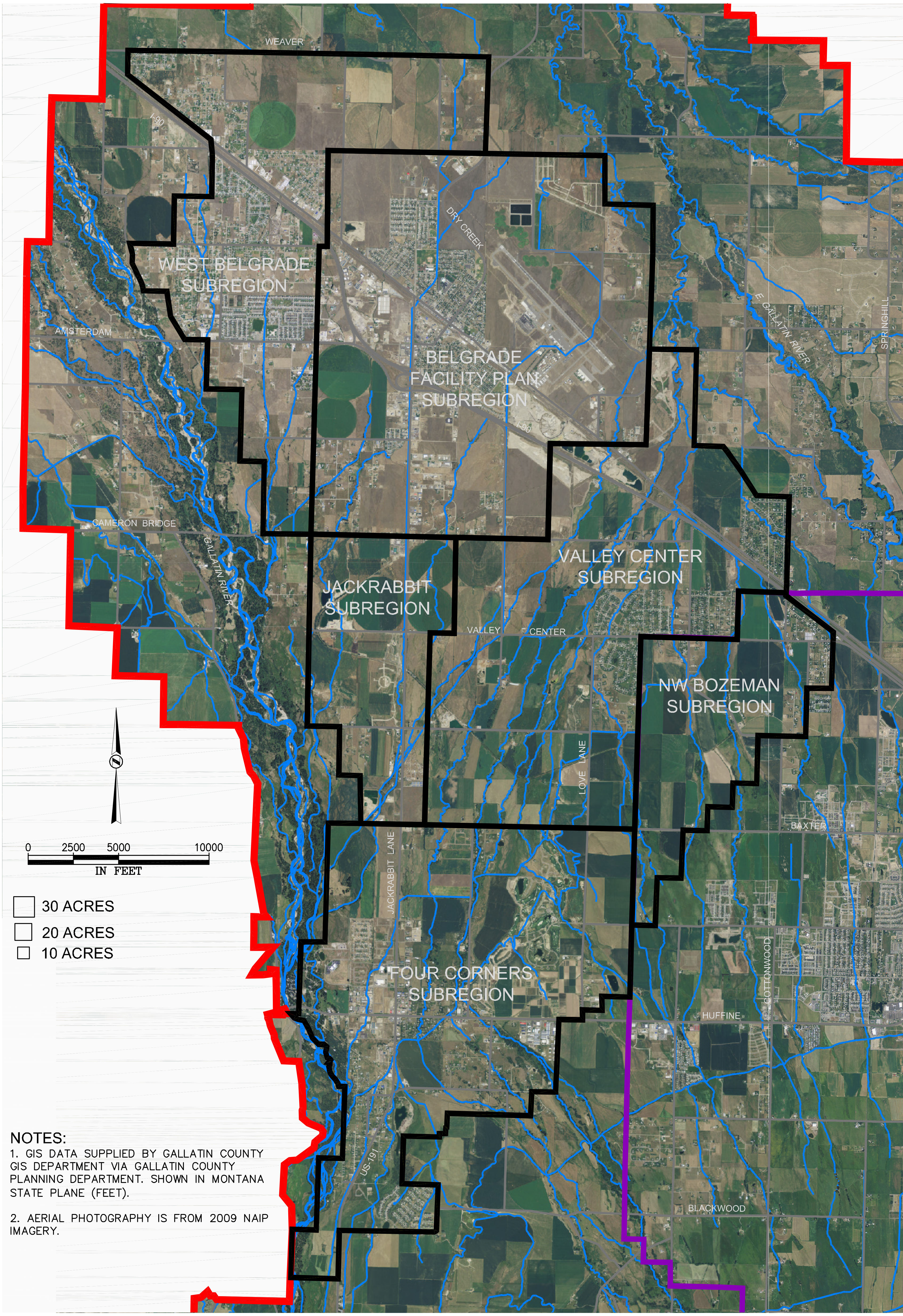
N:\0939-01809 GALLATIN COUNTY WW STUDY PH2\dwg\Figures\Fig -4B-3 Subregion Aerial enlrg.dwg, FIG-4B-3 PHOTO, Plotted: Sep 15, 2010 - 2:22pm, brickert



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SUBREGIONS AERIAL ENLARGEMENT

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PART 6
SCREENING OF ALTERNATIVE 10

SECTION A
INTRODUCTION & SUMMARY

1. INTRODUCTION

In this alternative, the economics of a hypothetical system serving portions of the West Belgrade and Valley Center sub-regions is explored over a 20 year time horizon. This alternative is different from other alternatives in that it examines the project at several points during its duration. The primary purpose in doing this is to demonstrate how a project might be implemented and what the effects of project phasing are.

Note: The scope of work for this study limits this analysis to the type, size, cost, and economics of the physical facilities. The water and wastewater subcommittee anticipates those essential administrative considerations such as legal, permitting, district or RID formation, staffing, impact and user fees, and financing will be examined at a more appropriate future date.

Collection, treatment, and disposal facilities are rarely constructed for maximum service capacity. Doing this would result in oversized facilities and unacceptably high costs on the front end. A more reasonable approach is to phase facilities so that initial costs are lower and the ability to service future population growth is maintained without overbuilding. The physical facilities are then extended and/or expanded as required by a combination of planning, zoning, and actual growth conditions.

Not all system components should be phased. A good example of this is raw land where future treatment and disposal facilities would be constructed. The early acquisition of these site(s) provides a known disposal capacity in a known location. This allows service areas and collection systems to be planned with more certainty and with fewer unintended future consequences. Another example is the permitted discharge capacity. Where possible, today's permitting activities should reflect anticipated future wastewater flows and loadings.

2. SUMMARY

As with previous alternatives, the previously presented zoning and population evaluations and cost calculation spreadsheets were used to generate estimates of collection, treatment, and disposal costs for the combined sub-regions of West Belgrade and Valley Center. Three different time intervals over a twenty year planning horizon were examined.

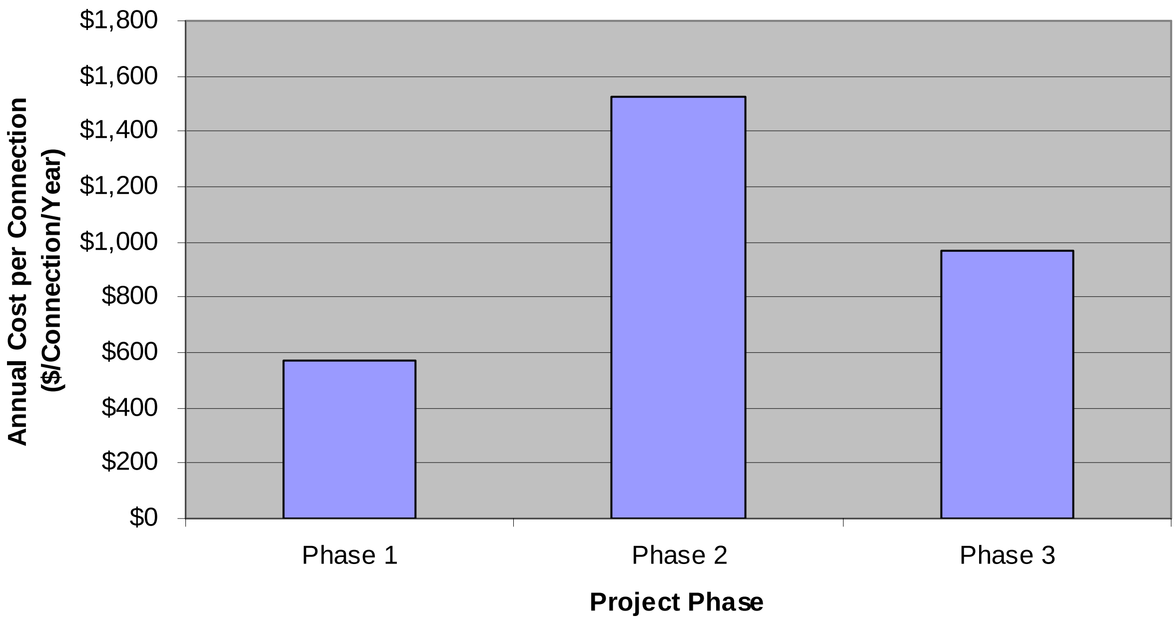
Figure 6A-1 is a plot of annualized cost versus project phase. As shown, the costs are lowest in the initial phase where both central trunk sewers and neighborhood sewers are constructed to service the existing populations. As was the case with the Lockwood, Montana project, sewers are built first followed by a second phase where the treatment and disposal facilities are constructed and immediately commissioned. A five year timeframe and possibly longer would be needed to complete Phases 1 and 2. The cost estimates are "snapshots" at the completion of each phase. Costs prior to completion of a particular phase may be lower than the values shown.

As shown, costs reach their maximum at the end of Phase 2 as all facilities become operational and capacity exceeds the current population. This estimate is conservative in that no participation by the areas inside the Belgrade facility planning area boundary is assumed. Construction of central collection and treatment facilities typically stimulates growth and or redevelopment in areas within or adjacent to the proposed service areas. These activities will typically generate significant amounts of connection and/or impact fees that can be used to reduce debt. No attempt to estimate this effect was made in these estimates.

Phase 3 represents a time period 20 years from the project start. At this point, the debt from Phase 1 has been paid off resulting in a substantial lowering of costs. Depending on the exact implementation time of Phase 2, its debt may also be significantly reduced by this time. (For this analysis, no adjustment was made for retirement of the Phase 2 debt.) As was discussed above, no attempt was made to account for growth and redevelopment activities stimulated by the presence of a central sewer system.

Beyond Phase 3, the cost structure continues to improve. At this point the trunk sewer network is complete and paid for. By about 25 years after starting the project, the Phase 2 debt is then retired. Additional neighborhood level sewers necessary to service additional population growth would most likely be constructed by developers resulting in a lower public financing requirement. At some future point, the treatment and disposal facilities would require expansion. With little remaining debt and significantly more users, a facility expansion would be unlikely to increase annualized costs significantly. Depending on actual population growth and actual administrative components such as impact fees, the annualized system costs may even continue to decrease over time.

Figure 6A-1
Annualized Cost Versus Phase



Starting in Section B below, this alternative is evaluated in more detail including a description, a population and flow summary, maps, economics, and a brief discussion of the general facility requirements and considerations.

SECTION B
SCREENING OF ALTERNATIVE NO.10
COMBINED WEST BELGRADE & VALLEY CENTER CCT

1. DESCRIPTION AND LOCATION

West Belgrade

As shown previously in Figure 4A-1, the West Belgrade sub region is located immediately west and north of the City of Belgrade facility planning boundary and extends from Cameron Bridge Road in the south to Weaver Road in the north. This sub region includes the River Rock, Landmark, High-K, and 4 Dot subdivisions. With a currently estimated population of 5881 persons, and a 20 year projected population of 7316, this mostly un-sewered (exception River Rock) population base makes this sub region well suited for central service or to become the initial phase of a larger system eventually serving multiple sub regions. In addition, this region is situated close to a large number of potential effluent disposal sites.

Valley Center

The Valley Center sub-region is located east of the Jackrabbit sub region and west of the City of Bozeman community plan boundary. The southern boundary is Baxter lane. Encompassing 6130 net acres excluding the Valley Grove subdivision, this area is the largest of the sub-regions. Given the current land use and zoning classifications, the current population of 2300 persons could increase to 6100 during the next 20 years.

2. POPULATION SUMMARY

The existing combined population of these areas is about 8200 persons corresponding to an overall density of about 0.7 persons per acre. As shown in Table 6B-1 below, the combined density is expected to exceed 1.0 by the year 2030. According to the current zoning, the build out density is approximately 3.5. If the planning and zoning density is reached, the population of this area would be 41,500 persons.

Table 6B-1
Alternative 10
Combined Population & Density

	Current (2010) Population & Density	Projected (2030) Population & Density	Zoned Density
Sub-Region			
West Belgrade	5881 (1.1)	7316 (1.5)	2.9
Valley Center	2309(0.34)	6130 (1.0)	4.0
Combined	**8190(0.69)**	**13,446 (1.2)**	**3.5**

3. ESTIMATED ANNUALIZED COST

Phase 1 Analysis

The expected Phase 1 timeframe is up to 5 years long. This phase includes land acquisition for treatment facilities and construction of centralized trunk sewers and neighborhood sewers for the existing population of 8200 persons. Because the collection system will take longer to build, this analysis assumes that it is constructed prior to the treatment and disposal facilities. As a result, there would likely be a period of time where costs were incurred before residential and commercial service could be started. (Note: There are a variety of methods for providing interim financing of the collection system; however, this topic is beyond the scope of this study)

An estimate of the initial collection system cost was computed as the ratio of the 20 year cost (previously developed in the collection system spreadsheets) to today's population. This result, about 26 million dollars, was then input into the combined model to estimate the annual cost per user. The Phase 1 input data are presented in Table 6B-2 below. As shown, several factors for treatment and disposal and for system operation and maintenance are marked not applicable because the system is not yet operational at this point. The combined model is presented in Table 6B-3. As shown, construction of the collection system infrastructure is estimated to cost $570 per connection per year. This cost, albeit low relative to other values developed in this study, represents the initial collection system investment and not a complete and functioning system.

Table 6B-2
Input Data for Phase 1 Analysis

Treatment System Construction Cost ($/Gal-Day of Capacity)	NA
Treatment System O&M Cost (Percent)	NA
Collection System O&M Cost ($ Annum/Mile)	NA
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	NA
Disposal System Construction Cost ($/Acre)	NA
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	100.0
Phase 1 Collection System Cost (Million)	26

Table 6B-3
Gallatin County Regional WW Study Phase 2
Collection, Treatment, & Disposal Spreadsheet
Alternative 10 Phase 1

Input Data	
Treatment System Construction Cost ($/Gal-Day of Capacity)	$0
Treatment System O&M Cost (Percent)	0
Collection System O&M Cost ($ Annum/Mile)	$0
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	1.00
Disposal System Construction Cost ($/Acre)	$0
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	100.0
Sub-Region Name	**WB+VC**
Sub-Region Est. 20 Year Population	8,200
Sub-Region Est. Current Population	8,200
Capital Cost Calculations--Treatment & Disposal	
Connections	3,565
Wastewater Flowrate (Gal/Day)	820,000
Land Required For Treatment & Disposal Facilities	32
Central Treatment Facility Cost	$0
Disposal Facility Cost	$0
Land Cost	518,000
Subtotal Treatment & Disposal	518,000
Capital Cost Calculations--Collection System	
Collection System Cost	$26,000,000
Public Financing Factor (%)	100
Subtotal Publically Financed Collection	26,000,000
Right of Way Acquisition @ 2%	$520,000
Subtotal Collection	$26,520,000
Total of Possible Capital Costs	$27,038,000
Annualized Cost Estimate	
Grant Allowance	($850,000)
Debt or Loan	$26,188,000
Debt or Loan Reserve	$2,032,189
20 Year Bond or Loan 3.75%	$28,220,189
Annual Payment for Debt Service	$2,032,189
Annual Treatment System O&M	$0
Annual Collection System O&M	$0
Subtotal of Annual Costs	$2,032,189
Treatment & Disposal Debt Service ($/connection-year)	$11
Collection Debt Service	$559
Collection, Treatment & Disposal O&M	$0
Total	$570

Phase 2 Analysis

The expected Phase 2 timeframe is between years 2 and 5; the only requirement is that the treatment and disposal facilities be operational about such time as Phase 1 is complete. With the Phase 1 collection system either completed or substantially completed, Phase 2 of this example would then construct and commission the treatment and disposal facilities. In this case, a design population of 10,840 persons was used. This value is the midpoint between the existing and projected 20 year population values. The Phase 2 input data are presented in Table 6B-4 below. These factors are similar to ones used in previously presented alternatives and should be familiar to the reader. The combined model for the Phase 2 analysis is presented in Table 6B-5. As shown, the estimated annual costs are about $1500 per connection per year when the system first comes on line. This value represents the case where the system capacity is much greater than the number of hookups.

Table 6B-4
Input Data for Phase 2 Analysis

Treatment System Construction Cost ($/Gal-Day of Capacity)	$22
Treatment System O&M Cost (Percent)	5
Collection System O&M Cost ($ Annum/Mile)	$3,600
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	1.00
Disposal System Construction Cost ($/Acre)	$350,000
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	100
Phase 1 Collection System Cost (Million)	26

Table 6B-5
Gallatin County Regional WW Study Phase 2
Collection, Treatment, & Disposal Spreadsheet
Alternative 10 Phase 2

Input Data	
Treatment System Construction Cost ($/Gal-Day of Capacity)	$22
Treatment System O&M Cost (Percent)	5
Collection System O&M Cost ($ Annum/Mile)	$3,600
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	1.00
Disposal System Construction Cost ($/Acre)	$350,000
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	100.0
Sub-Region Name	**WB+VC**
Sub-Region Est. 20 Year Population	10,840
Sub-Region Est. Current Population	10,840
Capital Cost Calculations--Treatment & Disposal	
Connections	4,140
Wastewater Flowrate (Gal/Day)	1,084,000
Land Required For Treatment & Disposal Facilities	42
Central Treatment Facility Cost	$23,848,000
Disposal Facility Cost	$8,709,826
Land Cost	518,000
Subtotal Treatment & Disposal	33,075,826
Capital Cost Calculations--Collection System	
Collection System Cost	$26,000,000
Public Financing Factor (%)	100
Subtotal Publically Financed Collection	26,000,000
Right of Way Acquisition @ 2%	$520,000
Subtotal Collection	$26,520,000
Total of Possible Capital Costs	$59,595,826
Annualized Cost Estimate	
Grant Allowance	($850,000)
Debt or Loan	$58,745,826
Debt or Loan Reserve	$4,558,676
20 Year Bond or Loan 3.75%	$63,304,502
Annual Payment for Debt Service	$4,558,676
Annual Treatment System O&M	$1,653,791
Annual Collection System O&M	$104,400
Subtotal of Annual Costs	$6,316,867
Treatment & Disposal Debt Service ($/connection-year)	$617
Collection Debt Service	$485
Collection, Treatment & Disposal O&M	$425
Total	$1,526

Phase 3 Analysis

Completion of Phase 3 occurs approximately 20 years from now. At this point, the treatment and disposal facilities have been expanded to serve the twenty year design population of 13,500 persons. By this time, the original Phase 1 collection system debt has been retired resulting in a significant reduction of debt. Depending on the timing of the phases and other administrative factors (not discussed) such as impact and connection fees, the Phase 2 debt may also be retired by this time. The Phase 2 input data are presented in Table 6B-6 below and the combined model for the Phase 3 analysis is presented in Table 6B-7. As shown, the estimated annual costs are about $770 per connection per year at the end of Phase 3.

Table 6B-6
Input Data for Phase 3 Analysis

Treatment System Construction Cost ($/Gal-Day of Capacity)	$22
Treatment System O&M Cost (Percent)	5
Collection System O&M Cost ($ Annum/Mile)	$3,600
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	1.00
Disposal System Construction Cost ($/Acre)	$350,000
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	100
Phase 1 Collection System Cost (Million)	Debt Retired
Phase 2 Treatment & Disposal Cost (Million)	Included

Table 6B-7
Gallatin County Regional WW Study Phase 2
Collection, Treatment, & Disposal Spreadsheet
Alternative 10 Phase 3

Input Data	
Treatment System Construction Cost ($/Gal-Day of Capacity)	$22
Treatment System O&M Cost (Percent)	5
Collection System O&M Cost ($ Annum/Mile)	$3,600
Treated Effluent Disposal Rate (Gal/Square Foot-Day)	1.00
Disposal System Construction Cost ($/Acre)	$350,000
Land Cost ($/Acre)	$10,000
Wastewater Production (Gal/Day-Person)	100
Residents Per Household	2.3
Collection System Percent Publically Financed	100.0
Sub-Region Name	**WB+VC**
Sub-Region Est. 20 Year Population	13,500
Sub-Region Est. Current Population	13,500
Capital Cost Calculations--Treatment & Disposal	
Connections	5,870
Wastewater Flowrate (Gal/Day)	1,350,000
Land Required For Treatment & Disposal Facilities	52
Central Treatment Facility Cost	$29,700,000
Disposal Facility Cost	$10,847,107
Land Cost	518,876
Subtotal Treatment & Disposal	41,065,983
Capital Cost Calculations--Collection System	
Collection System Cost	$14,500,000
Public Financing Factor (%)	30
Subtotal Publically Financed Collection	4,350,000
Right of Way Acquisition @ 2%	$87,000
Subtotal Collection	$4,437,000
Total of Possible Capital Costs	$45,502,983
Annualized Cost Estimate	
Grant Allowance	($850,000)
Debt or Loan	$44,652,983
Debt or Loan Reserve	$3,465,072
20 Year Bond or Loan 3.75%	$48,118,055
Annual Payment for Debt Service	$3,465,072
Annual Treatment System O&M	$2,053,299
Annual Collection System O&M	$162,000
Subtotal of Annual Costs	$5,680,371
Treatment & Disposal Debt Service ($/connection-year)	$534
Collection Debt Service	$57
Collection, Treatment & Disposal O&M	$377
Total	$968

4. GENERAL FACILITY REQUIREMENTS & CONSIDERATIONS

Wastewater Disposal Area
At a minimum, land would be acquired based on long term projections. This analysis used the 20 year projected population of 13,500 persons to establish a 52 acre land requirement. If additional suitable acreage was available for a reasonable price, it would make sense to use the planning and zoning population estimate of 41,500 persons to determine land requirements. In this case, the required amount is about 160 acres.

Referring to the previously presented study area constraints and aerial maps, there appears to be large parcels of suitable land in and around the Belgrade facility planning area. From a hydraulic standpoint, areas north of the Belgrade facility planning boundary and south of Weaver Road, may be best.

Conveyance
Conveyance system concepts for West Belgrade and Valley Center were previously presented in Parts 4B and 4E of this study respectively.

Water Rights
According to the previously presented discussion on water rights, the transport of effluent may be prevented by mitigation requirements of certain water rights most notably those established after 2003. Given the relatively short transport distances involved and the proximity of the disposal site to the water sources, this alternative has a lower risk of water rights complications. The mitigation requirements of all affected water rights must be carefully considered before planning such a system. Such an evaluation is beyond the scope of this project.

Water Quality Issues
A Montana groundwater pollution control permit would be required for this alternative. Even though the proposed disposal is to the groundwater, the ultimate destination for the treated effluent is likely to be down-gradient surface water. This effect increases with the volume disposed. Although the disposal system engineering process would attempt to minimize these impacts, it's likely that surface water impacts could be identified. The end result of this situation could be a requirement for the eventual conversion of the proposed Group 5 facilities to Group 6.

Facility Summary
A summary of the possible facility characteristics as a function of construction phase is presented in Table 6B-8 below.

Table 6B-8
Facility Summaries

Parameter	Phase 1	Phase 2	Phase 3
Population	8200	10,840	13,500
Flowrate (MGD)	0.82	1.1	1.4
Treatment Level	Group 5	Group 5	Group 5 or 6
Disposal Area (Acres)	32	42	52
Surface Water Impacts	Possible	Possible	Possible
Water Rights Restrictions	Unlikely	Unlikely	Unlikely
Cost ($ per Connection/Year)	$570	$1,500	$970

PART 7

CONCLUSIONS & RECOMMENDATIONS

CONCLUSIONS & RECOMMENDATIONS

1. INTRODUCTION

This study is the result of community and agency (Gallatin Local Water Quality District [GLWQD]) concerns over high levels of expected growth, and a county wastewater management policy that universally favors a decentralized network of on site and small community type systems. A key concern is that the combination of high future densities and a decentralized approach may eventually threaten local groundwater quality. Given that scenario, certain areas may be better served by a centralized approach to wastewater collection, treatment, and disposal. Accordingly, this study evaluates population and density projections reflecting recent planning and zoning activities undertaken by the Commission and, based on those projections, identifies the general characteristics and locations of centralized collection, treatment and disposal facilities. In all, ten different alternatives for centralized service are evaluated.

In addition to examining various central treatment alternatives, this study presents additional information intended to assist the County in evaluating the adequacy of its current wastewater management policy including:

- estimates for near term and long term population growth and density by specific location within the study area,
- an economic comparison of decentralized and centralized approaches to wastewater management,
- an overview of available wastewater treatment technologies and performance including a description of what other Montana communities are doing,
- an examination of important centralized treatment constraints including water rights, permitting restrictions, subsurface and surface water discharge considerations, and physical constraints including soil and groundwater characteristics, and,
- spreadsheet tools that can be used by county staff for the evaluation of additional alternatives.

2. BACKGROUND

Prior to the current recession, Gallatin County experienced a sustained period of rapid population growth. According to published data, the County's population increased from 50,463 in 1990 to an estimated 87,359 in 2007 (U.S. Census Bureau 2007). This growth rate equates to a 42 percent increase over the last 17 years. Based on data provided by the GLWQD, approximately 22,000 persons (59 percent of new growth) located in rural areas; this new growth was supported with onsite wastewater systems.

A detailed review of the existing county planning and zoning classifications indicates that substantial rural area growth may continue for many years. The study area examined for this report (See Section 3, Figure 3A-1) is expected to grow from about 30,000 persons to 60,000 persons by the year 2030.

Note:	Existing planning and zoning designations allow for as many as 260,000 persons within the study area boundaries.

At the present time, unincorporated areas of Gallatin County rely upon a de-centralized network of individual and/or community on-site wastewater treatment systems. For the most part, implementation of these systems use an approval process centered on existing DEQ regulations - if a proposed system meets DEQ design standards it's usually approved by the County. According to the GLWQD, these systems are often approved independently of each other with little follow-up to evaluate important parameters such as cumulative groundwater impacts and ongoing system maintenance and performance.

Gallatin County contains 135 different public (serving 15 or more connections) wastewater treatment systems not including major systems serving cities and towns. About 90 percent of these systems are un-permitted. These systems are thought to discharge a total of about 500,000 gallons of wastewater per day into the groundwater. Together with the approximately 13,000 privately owned systems, the total effluent flowrate discharged by these systems is estimated at 3.5 million gallons per day. When these combined flows are compared to other major effluent sources, they represent the second largest source next to the City of Bozeman treatment facility which discharges approximately 5 million gallons per day.

The GLWQD has studied many of these systems concluding that lack of routine monitoring; unknown physical condition and effluent treatment performance; and the un-permitted discharge of treated effluent to the subsurface are all significant concerns. As rural growth continues, the GLWQD and many residents are concerned that the continued reliance on individual and community on-site systems will produce cumulative effects that may someday degrade local groundwater quality. A good example of this potential is the River Rock subdivision wastewater facility that has allegedly polluted down gradient drinking water wells.

Although the GLWQD has limited resources for the investigation of the hundreds of individual and community systems, Gallatin County cannot conclude that groundwater quality degradation is not a problem. If the experiences of other Montana communities such as Missoula County and the unincorporated community of Lockwood (adjacent to Billings) are any sort of guide, then the expectation for additional future groundwater contamination should be the rule and not the exception. Both of these communities have been working for several years to remedy nitrate contaminated groundwater resulting from the long term over-reliance on decentralized wastewater technologies.

The continued reliance on de-centralized systems is beginning to have significant repercussions within our community. For example, the author is aware of several commercial facilities with older on site systems that no longer function correctly. In most of these cases, the combination of new regulations and poor site (soils and groundwater) conditions are preventing system upgrades. Without viable long term alternatives for sewage treatment, some of these businesses may be forced to unnecessarily relocate (or possibly close) causing economic disruption to both the owners and employees.

3. STUDY METHODS

The study area population and density projections form the basis of this work. With the majority of the study area either planned and/or zoned, it's possible to more accurately project future populations and densities within the study area. Overall growth rates were determined using a three (3) percent net growth rate multiplied by the total population within the study area including excluded areas. This method accounts for the fact that growth occurring in excluded areas, such as Bozeman, impacts nearby unincorporated areas. The Gallatin County geographical information systems (GIS) database was then used to distribute the growth across the study area according to the planning and zoning characteristics of each land parcel within the study area. As a result, areas that are zoned for growth were allocated a higher proportion of growth than areas with lower densities.

The project team also developed spreadsheet models for estimating the characteristics, size, and cost of various types of wastewater collection, treatment, and disposal systems. The spreadsheets use population and service area as primary inputs. Outputs include collection, treatment, and disposal system sizes, land requirements, capital, and operating costs. When used in conjunction with the

County's GIS database and population distributions, the spreadsheets facilitate rapid analysis of multiple wastewater management scenarios.

These spreadsheet models were also used to determine the economics for many of the decentralized system types now in use within the study area. The objective in doing this was to compare the life cycle costs of decentralized technologies to centralized system costs and to estimate the cost impact of future discharge regulations on the owners of decentralized systems.

With the population distributions and general facility characteristics known, the project team identified possible locations of these facilities. Potential sewer routes were based on factors such as topography and proximity to population centers and suitable effluent disposal sites. Treatment and disposal sites were identified by screening the GIS database to exclude areas with unsuitable characteristics by considering the location of surface waters, depth to groundwater, soil type, and physical interferences such as roads, structures, conservation easements, et cetera. Both the suitable and unsuitable sites were marked on the constraints maps providing a valuable planning tool useful for future related county activities. Administrative and legal constraints affecting various centralized treatment and disposal alternatives, such as water rights restrictions, were also identified and discussed where appropriate.

4. STUDY CONCLUSIONS

Major study conclusions are presented below. The conclusions are organized according to the originating section of the report.

Part 3A Study Area Definition

- Part 3A of this study presents the methods for projecting future populations within the study area. As discussed there, the Gallatin County GIS database, and existing planning and zoning designations, were used to distribute estimated future population growth according to zoning. This method is more precise than conventional methods that assume areas with high existing populations will continue to grow at high rates. In fact, in areas zoned for growth, the population tends to grow faster than in more mature areas. This effect is quite evident in rural Gallatin County where more than half of recent growth occurred outside population centers served by central sewer systems.

- A three (3) percent growth rate was applied to the entire existing population within the study area boundary. This allows for the fact that growth created by Bozeman and other excluded areas affects the growth of nearby unincorporated areas many of which are within the study area. (These projections are summarized in Tables 3A-2 and 3A-3 of the report.). Due to recent planning and zoning efforts, the study area 2030 population will be approximately 60,000 with about 36 percent or 22,000 located in portions of the study area having growth favored zoning.

- Similarly, the study area build out population will be approximately 260,000 with about 77,000 located in portions of the study area having growth favored zoning.

- The corresponding year 2030 densities in certain study area sub-regions will range from about 0.8 to 1.4 persons per acre increasing to between 3 to 6 persons/acre at build out. (Note: As a point of reference, Lockwood, Montana implemented a regional collection and treatment program at a current density of approximately one (1) person per acre.)

- Much of the land within the study area is zoned at densities that are unlikely to support centralized treatment. However, there are several key sub-regions within the study area where centralized treatment concepts are plausible. As a result, much of the study focused on the following six sub-regions:

  West Belgrade Area
  Belgrade Facility Plan Area (Outside the city limits)
  Valley Center Area
  Jackrabbit Area
  Four Corners Area
  Northwest Bozeman Community Plan Area

- Localized growth and infill rates within these sub-regions could be much higher than the overall study area population growth rate of 3 percent. This suggests that economical densities may be more rapidly attained than earlier engineers had thought. For example, Table 1-1 below indicates that the 20 year growth rates of certain sub-regions could exceed 100 percent. The corresponding densities are provided in Table 1-2 and show that by 2030, several sub-regions could meet or exceed densities of at least one (1) person/acre.

Table 1-1
Study Area Sub-Region Growth Rates

	Overall Population Change Year 2030	Overall Population Percent Change Year 2030
Sub-Region		
West Belgrade	+1435	+24
Belgrade Facility Plan Boundary Outside City Limits	+5600	+73
Valley Center	+3821	+165
Jackrabbit	+1525	+700
Four Corners WSD and areas served by Utility Solutions	+3618	+100
Northwest Bozeman	+2303	+650

Table 1-2
Study Area Sub-Region Density Information

	Projected Density (persons/acre) 2030	Zoned Density
Sub-Region		
West Belgrade	1.4	2.9
Belgrade Facility Plan Boundary Outside City Limits	1.1	3.0
Valley Center	0.90	4.0
Jackrabbit	0.80	4.3
Four Corners WSD and areas served by Utility Solutions	1.1	4.0
Northwest Bozeman	1.1	6.0

Part 3B Constraints Analysis

- Part 3B of this study evaluated a variety of constraints that could complicate the implementation of a centralized collection, treatment, and disposal facility. Of the many constraints identified, water rights could have significant impacts on the scope and location of any centralized facility. Essentially, the collection and disposal of wastewater is considered a diversion that may require mitigation. Because mitigation is only required for new water rights obtained after 2003, this issue would primarily affect recently established and planned future growth unless served by existing water rights that are free of mitigation provisions. The operator of a centralized wastewater facility may be able to mitigate any constraints through a variety of avenues including the acquisition of a mitigating water right or by using a wastewater disposal location located close to the fresh water source.

- Study area physical constraints such as depth to groundwater, soil type, and surface water locations are mapped in Figure 3B-1 of this report. This map suggests that a limited amount of land is suitable for locating and successfully operating a centralized wastewater treatment and ground water disposal facility. As much of this land is located in or near prime development corridors, the quantity of well located land with the required soil and groundwater conditions will continue to diminish over time. A good example of this trend is the Gallatin Heights subdivision, on Jackrabbit Lane, that was built on a site having excellent characteristics for a regional wastewater disposal facility.

- The lack of a central collection and treatment system will not prevent development within the study area. This is because state agencies are familiar with many decentralized technologies and will readily approve them. As a result, land development projects will continue without consideration for the need to preserve sites for possible future centralized facilities.

- Surface water discharge options are severely limited by a variety of discharge standards, most notably the non-significance trigger values for nitrogen and phosphorous. Examples of these restrictions can be found in Figures 3B-2 and 3B-3 of this report. These restrictions may be reduced if a credit for the removal of existing on site systems can be negotiated with the Montana Department of Environmental Quality (DEQ). In this case, the higher removal efficiencies of a central facility would allow for it to serve more people with an equal or lower impact to the receiving water. Such an arrangement would require case by case negotiations with DEQ.

Part 3C & 3D Overview of Decentralized & Centralized Wastewater Treatment Technologies and Economics

- Part 3C and 3D of this study examine the treatment performance and economics of decentralized and centralized wastewater facilities. An economic comparison shows that over the long run, central treatment is more economical than individual on-site systems. For example, the ownership cost of decentralized (on-site) wastewater treatment systems ranges between about $2,000 and $4,000 per connection per year. In comparison, the cost of the centralized collection, treatment, and disposal facilities evaluated for the highest density sub-regions ranged from about $1,000 to $1,500 per connection per year.

- In addition to lower long term costs, centralized systems can produce an effluent significantly lower in conventional pollutants, nitrogen, and phosphorous than decentralized systems. In the case of new or more stringent effluent quality regulations, a centralized system is more easily upgraded than hundreds of individual systems.

- Because the cost of decentralized systems is typically included in the price of a home or commercial building, many people incorrectly assume that these systems have no cost. They are often unaware that wear and tear and depreciation are also significant long term costs. The true cost of these systems is often not apparent until a system fails and must be replaced. Some business owners along the Jackrabbit corridor are currently facing unaffordable upgrades to their older, failing on-site systems. As mentioned before, some of these owners are faced with the possible relocation or closure of their facilities because alternatives to on-site disposal are not available at this time.

Part 3E Spreadsheet Tools

- The cost of centralized wastewater collection, treatment, and disposal facilities is affected by a variety of factors each of which is discussed in Part 3E of this report. Of all the factors, the collection system cost has the largest effect on overall costs. Because the study area contains large tracts of undeveloped land, it's unlikely that sewer service to these areas would be 100 percent publically financed. More likely, developers would finance and install neighborhood sewers (defined as 12-inches or less) in grass roots developments with subsequent connection to a publically financed central trunk sewer. To account for this implementation method and the resulting range of collection system financing possibilities, the analysis spreadsheets include public financing factors that can be varied from 30 percent to 100 percent.

Part 4 Screening of Alternatives 1 Through 6

Part 4 conceptually evaluates collection, treatment, and disposal systems for several individual sub-regions selected from within the study area. These sub-regions, relative to the overall study area, are projected to contain the highest future densities and may represent the best opportunities to someday establish economical centralized collection, treatment, and disposal systems. The sub-regions are listed below and are also shown on Figure 4A-1.

Alternative 1. West Belgrade Central Collection & Treatment (CCT)
Alternative 2. Belgrade Facility Plan Area CCT
Alternative 3. Jackrabbit CCT
Alternative 4. Valley Center CCT
Alternative 5. Northwest Bozeman Community Plan CCT
Alternative 6. Four Corners CCT

- Because of higher current densities, the central treatment system economics for Alternatives 1, 2, or 4 are initially more favorable than for Alternatives 3, 5, or 6. If a centralized system was pursued by the County, the starting point should include one or more of the service areas identified in Alternatives 1, 2, or 4. Over the next 20 years, densities in all of these areas should produce central system costs in the range of $1,000 to $1,500 per connection per year.

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- A centralized treatment strategy that initially includes portions of the West Belgrade and Valley Center sub-regions, and possibly other (interested) adjacent areas, has the highest chance for success due to its current population density, favorable elevation for gravity sewers, and proximity to potential groundwater disposal areas. Such a system could be expanded to the south to incorporate additional sub-regions as their density increases and conditions permit. This concept is explored in more detail in Alternative 10 (Part 6 and below).

Part 5 Screening of Alternatives 7 Through 9

Part 5 conceptually evaluates collection, treatment, and disposal systems for larger portions of the study area. Each of these alternatives is briefly described below along with the corresponding conclusions.

- Alternative 7 considers a fully regional system serving the entire study area; in this alternative, average study area densities are assumed and then used to determine the overall system economics. This alternative is not feasible. Much of the land within the study area is zoned at densities that are unlikely to support centralized treatment. Serving these low density areas is uneconomical because the necessary collection system costs are too large and the rate payer base too small. If a centralized system serving the entire study area was constructed, an average density of at least 4 persons per acre would be necessary to achieve a reasonable cost structure. As the overall study area is planned and/or zoned at an average density of 2.8 people per acre, a fully regional system is not considered feasible.

- Alternative 8 explores the possibility of treated effluent hydropower generation with disposal in the Missouri River near Trident, Montana. In this case, a pressure pipeline is used to connect a treatment facility located northwest of Belgrade to a hydropower generation and effluent discharge facility located near Trident, Montana. This alternative has a variety of technical problems that most importantly include Missouri River non-degradation significance trigger levels that are difficult and expensive to meet and that also limit the amount of flow to the facility. Unfortunately, the power generation potential of this idea is miniscule when compared to the overall project costs. Lastly, the analysis shows that the cost of a pipeline to Trident, approximately 22 miles, is significantly more than the cost of groundwater disposal facility near Belgrade.

- Alternative 9 is identical in scope to Alternative 8 except that the Missouri River discharge option is replaced with a groundwater disposal system also located northwest of Belgrade, Montana. Using previously established methods, the annualized cost range for this alternative is about $1,200 to $1,700 per connection per year depending on which modeling assumptions are used.

Part 6 Screening of Alternative10

- In this alternative, the economics of a hypothetical system serving the West Belgrade and Valley Center sub-regions is explored in three (3) phases over a 20-year time horizon. This alternative is different from other alternatives in that it examines a project at several points during its duration. Initial costs of around $600 per connection per year are required during the initial phase where both central trunk sewers and neighborhood sewers are constructed to service the existing populations. As was the case with the Lockwood, Montana project, sewers are built first followed by a second phase where the treatment and disposal facilities are constructed and immediately commissioned. At this point, costs would rise to around $1,500 per connection per year. Phase 3 represents a time period 20 years from the project start. At this point, the debt from Phase 1 has been paid off resulting in a substantial lowering of costs to around $1,000 per connection per year.

- The presence of a central system is likely to stimulate growth and development beyond existing estimates. As a result, the cost structures shown for this alternative are likely conservative.

- Of all the alternatives considered, alternative 10 appears to be the best. This alternative has many positive attributes including: proximity to current and future growth areas; ability to serve most areas by gravity flow; higher chances for redevelopment and infill leading to lower user costs; proximity to many possible groundwater disposal sites; and, being centered near Belgrade, is well positioned for expansion to the southern portion of the study area as future conditions require.

Additional Conclusions

- During the next 50 to 100 years, additional restrictions on groundwater discharge and water diversions will likely require that regional treatment facilities incorporate reuse technologies such as ultra filtration or reverse osmosis followed by indirect reuse of effluent. Indirect reuse would be accomplished by pumping treated effluent up-gradient and injection into the groundwater. This possibility must be considered in the design of any centralized treatment facilities.

5. RECOMMENDATIONS

1. Because the study area is planned and zoned for 60,000 persons by 2030 and eventually up to 265,000 persons, the County, in consultation with the GLWQD, should review its current (decentralized) wastewater management policy to assess if another 500 to 1,000 small to medium sized treatment systems represents the most efficient and reliable way to preserve and protect local water quality.

2. Given the many benefits of centralized treatment including cost effectiveness, higher pollutant removals, and ease of upgrade and expansion for future conditions, the County should review its current wastewater management policy to determine if a properly located and implemented central system can aid in the preservation of local water quality.

3. In the event that such a policy shift is needed or is simply of interest, the County should then evaluate the legal and administrative requirements necessary for the County, or for a county encouraged entity, to provide and/or facilitate centralized service to portions of the study area.

4. Pending a shift in its wastewater management policies, the County should also consider acquiring or otherwise preserving for the public benefit, certain lands that could be used for future wastewater treatment and disposal facilities. The identification of such lands should follow the guidelines contained in this study and should be confirmed by the engineer prior to making any commitments.

5. Further, the County should consider enhancing the subdivision review process so that potential routes of regional sewer trunk lines are preserved and that approved community systems contain provisions for the possible future connection to a central system.